AGRICULTURE & FOOD e-NEWSLETTER

ISSN: 2581 - 8317

Volume 2 - Issue 2
February 2020

Monthly online magazine covering trending and important aspects related to Agriculture, Horticulture, Food science, enviornment

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Agriculture & Food: e-Newsletter

(Monthly online magazine)

ISSN: 2851-8317

www.agrifoodmagazine.co.in

On Terminal bud: Ca & B

On Young Leaf: Cu, S, Fe & Mn

On old leaf: N, P, K, Mg, Zn & Mo

2020

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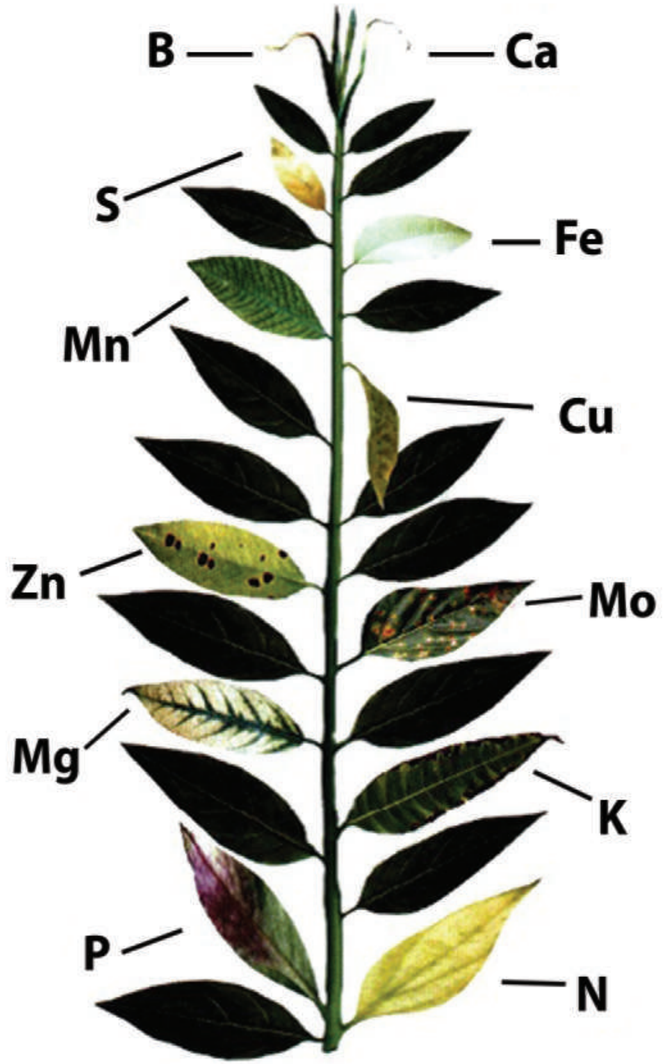

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 **Volume 2 – Issue 2 – February 2020**

Edible flower considerations as ingredients in food and medicine

Article id: 22800

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INTRODUCTION

Eat flowers that are known to be edible and grown by you as it has no pesticides. Edible flowers are the ideal way to add colour to your garden and interest to your plate. For centuries edible flowers have been an integral part of human nutrition and were already described in detail in ancient literature. Furthermore, flowers were used as decorations in food prepared for the nobility, especially for feasts and banquets. There are several reasons why the interest in edible flowers is continuously increasing. Globalization has contributed not only to a better awareness of consumers but also to the comeback of earlier lifestyles, in which edible flowers played an important role.

In China and Japan, edible flowers have been consumed for thousands of years. Moreover, new food-processing technologies as well as new logistic methods and quick distribution of cooled and well preserved foodstuffs have enabled us to return to earlier common and widespread food resources. This increasing demand has been and still is associated with efforts of producers and manufacturers of ready-to-cook food to extend and improve their offerings and to introduce new kinds of commodities. Nowadays, edible flowers are used as garnishes and mostly consumed fresh. Nevertheless, they can also be consumed dried, in cocktails (in ice cubes), canned in sugar, preserved in distillates, *etc*.

Their colours are predetermined by many chemical compounds but the contents of carotenoids and flavonoids are the most important. A high antioxidant capacity of flowers is mostly correlated just with the level of flavonoids. The main sources of edible flowers are vegetables as well as fruit, medicinal and ornamental plants. Particular species of edible flowers used in the work have different colours and taste—depending on different cultivars: *Antirrhinum majus* (yellow, bitter flavour), *Centaurea cyanus*, *Chrysanthemum frutescens* (orange yellow, slightly to very bitter flavour), *Dianthus caryophyllus* (dark pink, slightly bitter flavour), *Fuchsia x hybrida* (reddish and pinkish purple, slightly acidic flavour), *Impatiens walleriana* (pink, sweet flavour), *Rosa odorata* (red, sweet and aromatic flavour), *Tropaeolum majus* (red, sharp and cress-like flavour), *Viola x wittrockiana* (two coloured petals—yellow and violet, sweet flavour), to flowers consisting of only one colour: *Begonia boliviensis* (reddish orange, slightly lemon flavour), *Chrysanthemum parthenium* (white yellow, slightly to very bitter flavour), *Tagetes patula* (orange, bitterish, clove-like flavour).

Edible flowers at a glance

- Identify flowers and confirm they are not poisonous prior to eating.
- Consume only flowers that have been grown: - with either no pesticides or only pesticides labelled for edible crops; and - without the application of animal manure to the surrounding soil in the past four months.
- Harvest at peak bloom and use quickly for best flavour.
- Introduce new varieties of flowers into the diet slowly to screen for allergic reactions.
- Vary the ways you prepare edible flowers: fresh, cooked, candied, frozen, dried, or preserved in oils or vinegars.
- Use only edible flowers as garnishes to food.
- Enjoy the flavour, colour, and texture that flowers can bring to food.

Importance

The compounds of antioxidant action used by the food industries can be synthetic or natural, and those of greater use are those of synthetic nature. However, the celebrity of some synthetic antioxidants has been questioned, since there are studies demonstrating that they may favour mutagenic and carcinogenic effects. Numerous photochemical present in edible flowers are related to health-promoting benefits such as antioxidants, anti-inflammatory, anticancer, anti-obesity, hypoglycaemic agents, and substances with protective properties of the neurological, hepatic and gastro system.

The natural antioxidants are presented as an alternative to prevent oxidative deterioration of food, thus minimizing the damage that these oxidative compounds would cause in humans. The colours of the flowers, as well as the colours of fruits and vegetables, indicate the presence of photochemical such as polyphenols or phenolic compounds, flavonoids, carotenoids and anthocyanins.

To the extent that research defines the health benefits of physiologically active components in flowers, they may still have potential for use as an additive in food to help prevent chronic disease and even oxidation of food. One of the biggest concerns related to flower consumption is its possible toxicity. Edible flowers can add distinctive flavour and provide a unique touch of colour to foods. However, not all flowers are edible, it is important to correctly identify each species and know which parts of the flowers should be consumed. The flowers of florists, nursery or garden centres, are commonly treated with pesticides, fungicides and herbicides not rated for food crops, and should not be used in the formulations and n and m as accompanying diets.

The search for raw materials that are beneficial to health and do not cause undesirable sensorial changes to the final product has gained emphasis and intensified interest in bioactive compounds of plant origin. These compounds have great commercial appeal due to their biological action and their use in the development of functional foods and also to become an alternative as food additives (dyes, flavourings, antioxidants and preservatives). The nutritional need required by the human body in health and disease states has been the object of intense research in recent years, as well as the concern about the chemical characterization of foods with economic and nutritional potential, especially those of low caloric value, since obesity and chronic-degenerative diseases become prominent in public health.

Some edible flower importance and uses

Hibiscus: A tea made from hibiscus is popular in Egypt and Brazil, while in Mexico dried hibiscus flowers are easily found in shops and markets. Often used as garnish in salads, hibiscus or shoe flower are also brewed as tea. They are also common in the UK, in jars of syrup. Known to contain anthocyanins and antioxidants, they are also said to lower blood pressure and cholesterol levels.

Borage/Starflower: Known as the herb of gladness. This brilliant blue flower one of the rare existing blue foods has been used to combat depression and other types of emotional distress. The flower's origins lie in Syria where it is prized for its honey-like taste. They can be tossed into salads or crystallised to make a “candy”. Star flower oil helps to regulate metabolism and lower blood pressure. When cooking with flowers, remember to keep the dishes simple, as the gentle flavours easily become overpowered by stronger-tasting ingredients.

Violet: Violets are as pleasing to the eye as they are to the palate, which is why they can sometimes be found crystallized in sugar as a garnish on dessert or scattered through a gourmet salad to add some colour. They can help with a headache or cough and are even known to relieve pain. The flowers can be

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crystallised as beautiful candies; made into a delicate jelly and boiled, pressed, pounded, and mixed with milk, rice flour and sugar into porridge.

Rose: Rose is one of the most popular, exquisite and loved flowers all over the world. There are over 100 species within the family of Rosaceae found in variable colours and hues, each having their own distinctive medicinal and biochemical properties. Rose hips are the swollen bases of the flower that develop into seed pod. They contain vitamin C, malic and citric acids, antioxidants, photochemical and bioflavonoid (substances helping to promote health). Rose hips have been used therapeutically in the management of arthritis (inflammation of the joints), constipation and indigestion, urinary problems, fevers, colds and flu's, cancers, bladder stones, and gonorrhoea (sexually transmitted infectious disease). Rose petals are also a rich source of vitamin A, B3, C, D, E, volatile oils, tannic acid, malic acid, pectin, bioflavonoid and antioxidants. Rose petals tea is prized for eliminating stress and headaches, treating depression, insomnia and other nervous disorders. . It is also used as a blood purifier, laxative, diuretic, cardio-tonic, as an anti infective agent for the digestive system and the respiratory system. It is also known to be a regulatory aid for infertility and menstrual problems. The ayurvedic tonic gulkand is prepared from the rose petals and is used to treat disorders varying from fatigue to intestinal worms to hyperacidity. It is also known to have hepatoprotective properties.

Lotus: All parts of the lotus can be consumed which including its petals, flowers, flower stamens, seeds, and stems. This flower helps in the management of fever, sunstroke, insomnia, urinary problems, diarrhoea, dysentery, cough, and cold. It is effective in reducing blood sugar and blood pressure and should be used with caution in patients taking medications for the same. Lotus is also known to be an antioxidant (reduces the damaging free radicals in the body) and researches have shown that the lotus rhizome extracts have the highest antioxidant properties. It is also cardiotonic, hepatoprotective (protects the liver), reduces cholesterol and acts as an astringent.

Jasmine: A fragrant flower, it usually blended with green tea and added to salads. It is said to have anti-carcinogenic and anti-viral properties.

Marigolds: Popularly known as genda phool in India, the Chinese are known to use marigolds in tea. The flower is also used topically to heal wounds. The flower is also said to be high on the pigment lutein, also known as eye vitamin, which is necessary to keep eye diseases at bay.

Calendula: calendula flower found on the edible flowers that aid digestion, reduce fevers and stimulate the immune system.

Lavender: This fragrant flower is used as a flavour in ice-creams and yogurts. However, it also acts as an anti- septic and can also be used to get rid of dandruff.

Chamomile: Known for its calming effects, chamomile is often had in tea. It is believed to have anti-inflammatory, anti-carcinogenic and wound healing properties.

Pansies: These bright coloured big flowers not only makes pretty picture, but is beneficial for your heart, kidney, blood pressure among others as its high on potassium and other minerals.

Saffron: Saffron has many antioxidant and medicinal properties besides its use in imparting color and flavor to many exotic dishes. Traditionally it is used as an antioxidant, antiseptic, antidepressant,

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digestive, carminative and anti-carcinogenic agent. Safety in young children, nursing women and in people with liver and kidney diseases has not been established.

CONCLUSION

There is a great demand in the market for natural products derived from plants. The edible flowers have in their constitution proteins, lipids, carbohydrates, minerals and vitamins, important for the food industry, medicines and cosmetics. The antioxidant activity and phenolic compounds present in flowers provide several beneficial effects to human health. Thus, edible flower extracts or use of fresh flowers may be a viable alternative as a natural antioxidant in place of synthetic antioxidants in the food and pharmaceutical industries.



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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Plant Growth Regulators: A boon to increase vegetable production

Article id: 22801

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Plant Growth Regulators (PGRs) are the organic or chemical substances applied externally in order to modify several physiological processes like seed germination, seedling growth, development, flowering, fruit set and it ripening as well as to improve its storage life. Application of appropriate PGR at specific dosage at specific plat growth stage will ultimately improve the productivity. Moreover it will reduce the post harvest decay of the vegetable crops, which will lead to greater profitability of the farmers.

Definition of PGRs

Plant Growth Regulators (PGRs) are any organic or chemical substance, other than nutrients and vitamins, when applied in appropriate quantities can regulate the growth of plants either by promoting, retarding or modifying natural physiological processes.

Plant hormones versus PGRs

Plant hormones or *phytohormone* are the organic compounds synthesized naturally at the specified sites of the plants and transported to other parts where they cause physiological response, whereas, PGR primarily denote a single or group of chemicals, externally applied to specific growth stages of plants in order to manipulate the physiological processes like growth, development, sex expression etc.

Characteristics PGRs

- ✓ They are chemicals or artificially synthesized hormones that have the same physiological role like naturally occurring *phytohormones.*
- ✓ Very specific in action.
- ✓ Active in very minute concentration (ppm or ppb level).
- ✓ Alters physiology of plants by altering the endogenous *phytohormone* level.
- ✓ They may show altered physiology and/ or phytotoxicity at higher doses.

Application of PGRs in major vegetable crops

- **Enhancement of seed germination:** Pre-sowing seed treatment with NAA @ 20 mg/l enhances seed germination in okra and Solanaceous vegetable crops, whereas, seed soaking in ethephon @ 480 mg/l for 24 h improved germination in muskmelon, bottle gourd, squash melon and watermelon at low temperature.

- **Induction of flowering:** Application of GA_3 @ 50mg/l to non flowering potato results into profuse flowering even under short day condition. This strategy can also be applied to induce flowering in any long day plant under short day conditions.

- **Reduce flower abscission:** Pre-bloom application of 2, 4-D @ 2-5 ppm reduced flower abscission before pollination in tomato, brinjal, chilli and capsicum.

- **Increase fruit set in adverse weather:** NAA @ 40 ppm or GA_3 @ 10-20 ppm are used to enhance fruit set in Solanaceous vegetable crops, especially chilli (Chaudhary *et al*. 2006).
- **Induce parthenocarpy in vegetables:** Para-chlorophenoxy acetic acid (PCPA) or GA_3 @ 50 ppm is reported to induce parthenocarpy in tomato and cucumber.
- **Increase draught tolerance:** Chlormequat Chloride @ 50 ppm is used in pea to protect against drought.
- **Suppression of sprouting and increase storage life:** Application of Maleic Hydrazide (MH) @ 1500-2000 ppm 15 days before harvest of onion and garlic results into sprout suppression and enhanced storage life. Chloropropham (CIPC) acts as sprout suppressant in potato.
- **Breakdown of seed and tuber dormancy:** To induce germination of potato tubers before the end of the resting period, vapour treatment with ehylene chlorohydrin @ 1ml per 20 kg followed by thiourea @ 1% for 1 hour and lastly treatment with GA_3 @ 1 ppm for 2 seconds is followed. This is known as 'triple treatment'.
- **Chemical gametocides:** Functional male sterility can be induced by application of Maleic Hydrazide @ 100 to 500 mg/l in okra, okra, peppers and tomato, GA_3 in onion, 2,3- dichloro-isobutyrate (0.2 to 0.8%) in okra, muskmelon, spinach and tomato. These male sterile plants can effectively be utilized as female parent in hybrid seed production.
- **Artificial ripening:** Ethrel @ 400 ppm is used for inducing ripening in climacteric fruit vegetables like tomato and muskmelon.
- **Enhancement of fruit yield:** Seed soaking in napthoxy acetic acid (NOA) @ 25-50 mg/l have been reported to improve yield in tomato.
- **Regulation of sex expression in cucurbits:** The most primitive sex form in cucurbits is hermaphrodite and the most advanced sex form is monoecious and up to 8 sex forms have been reported in different cucurbit species. For a farmer, more number of pistillate (female) flowers are desired but for a breeder, staminate and pistillate flowers are of equal importance for maintaining any gynoecious line.

General recommendation of growth regulators for sex manipulation in cucurbits

	Chemical (s)	Dosage (ppm)	Crop (s)
For inducing staminate (male) flowers	Gibberellic acid (GA_3)	1500-2000	Most monoecious cucurbits
	Silver nitrate ($AgNO_3$)	200-300	
	Silver thiosulphate ($Ag_2S_2O_3$)	300-400	
	Amino ethoxy vinyl glycine (AVG)	50-100	
For inducing pistillate (female) flowers	Tri-iodo benzoic acid (TIBA)	25-50	Watermelon
	Ethrel	250-400	Bottle gourd and Bitter gourd
	Etherel	250-500	Rest all monoecious sp.
	Napthalene Acetic Acid (NAA)	25-100	Ridge gourd, Sponge gourd
	Maleic hydrazide (MH)	50-150	Most monoecious sp.

Mia *et al.* (2014); Chovatia *et al.* (2010), Dixit *et al.* (2001); Sanchita and Phookan (2013).

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

CONCLUSION:

Plant Growth Regulators (PGRs) play a key role in different physiological processes like germination, growth, development, flowering fruit set, flowering, fruit yield and it's ripening by altering the endogenous phytohormone levels in different vegetable crops. The effect of the applied chemicals are largely dependent upon the genetic makeup of the variety, cropping season, crop growth stage at which it is applied, prevailing environmental conditions, especially the temperature and photoperiod. Application of right PGR at right time and at right dosage can effectively increase the productivity of the vegetable crops as well as can reduce the post harvest loss, which will further lead to greater profitability to the farmers.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Problems and Prospects of Sugarcane Growers in Tamil Nadu

Article id: 22802

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INTRODUCTION

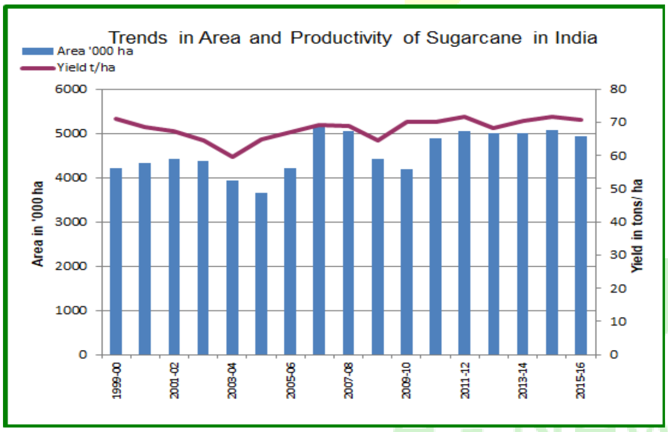
Sugarcane (*Saccharum spp.)* accounts for the largest value of production and holds an enviable position among all the commercial crops in India. India has the largest area under sugarcane cultivation in the world and the world's second-largest cane producer next only to Brazil. It is the third-largest crop, next to rice and wheat and also the sugar industry is the second largest agro-based industry next to cotton textiles in India. Sugar Industry is the backbone of rural economy and contributes significantly to their employment as the sugar mills are located in the rural areas. The various by-products of sugar industry also contribute to the economic growth by promoting a number of subsidiary industries.

Importance of Sugarcane

Sugarcane is emerging as a multi-product crop used as a basic raw material for the production of sugar, ethanol, electricity, paper etc. The importance of sugarcane agriculture is that it can meet the huge domestic requirement, which otherwise would have necessitated massive imports.

Sugarcane has been projected as the crop for the future contributing to the production of not only sugar but biofuel and bioenergy as well. By 2050, the population in the country is expected to reach 1.65 billion. At the present rate of growth in consumption, the requirement of sugar will go up from 23 million tonnes to 48 million tonnes (ICAR-SBI, 2015). This needs effective strategies and careful planning taking into account the projected targets, factors affecting productivity and sustainability.

Sugarcane cultivation and its Scenario



In India sugarcane is cultivated in an area of 4.74 million hectares producing 379.9 million tonnes of cane with an average productivity of 80.2 t ha^{-1} (indiastat.com). The crop scenario will fluctuate considerably from year to year which is due to variations in climatic conditions, the vulnerability of areas cultivated under rainfed conditions, fluctuations in prices of gur and khandsari, and changes in returns from competing crops (fao.org).

Fig 1. Area and Yield trends of Sugarcane in India

There are broadly two distinct agro-climatic regions of sugarcane cultivation in India, viz., tropical and subtropical. However, for the purpose of varietal development five agro-climatic zones have been identified mainly, they are (i)North Western Zone (ii) North Central Zone (iii) North Eastern Zone (iv) Peninsular Zone (v) Coastal Zone. (farmers.gov.in)

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Uttar Pradesh is the highest sugarcane producing State in sub-tropical zone having area about 22.34 lakh hectares with the production of 177.03 million tonnes cane whereas Haryana has the highest productivity of 84.5 t ha^{-1} in Sub tropical zone. In Tropical zone, Maharashtra is the major sugarcane growing state covering about 9.02 lakh hectares area with the production of 82.98 million tonnes, whereas the productivity of Tamil Nadu is highest in tropical zones. Sugarcane is one of the traditional crops grown abundantly across the state of Tamil Nadu and Currently, 1.72 lakh hectares are under cane cultivation producing 17.2 million tonnes of sugarcane with an average productivity of 99.8 t ha^{-1} but the area is declining since 2012 (Source:indiastat.com, for the year 2017-2018).

Estimation by ISMA

The industry body Indian Sugar Mills Association (ISMA) revealed that Sugarcane area in Tamil Nadu for 2019-20 sugar season (SS) has decreased to about 2.30 lakh hectare as against 2.60 lakh hectare in 2018-19 SS, mainly due to deficient rainfall in major cane growing districts during NE monsoon 2018. Sugar production is expected to be around 7.5 lakh tonnes in 2019-20 SS as against 8.60 lakh tonnes expected to be produced in 2018-19 SS (economictimes.indiatimes.com).

India produced an all-time high 33.16 million tonnes of sugar in 2018-19 but for the first time since 2016-17, the country will produce less sugar than the year before at about 26 million tonnes. It is observed to be the steepest decline of 21.6% in over a decade, during the sugar season 2019-20 as errant monsoon this year is likely to lead to a 12 per cent less acreage this year. The estimated production figure is also around 8 per cent lower than the earlier estimate of 28.2 million tonnes that ISMA had projected in July 2019. The projections confirm widespread fears that errant monsoons this year may have adversely affected crop acreage in the country. Monsoons were patchy in the first half of the season--June and July, but widespread in the second half--August and September, leading to initially a drought and then a flood-like situation in many areas. Though the fall in production is up to 21.6 % in 2019-20 however, is not a bad thing (according to the ISMA's estimate). The consumption of sugar estimated for 2019-20 is around 26 million tonnes which would be the same as the amount of sugar that will be produced. The industry is, however, carrying an all-time high carry overstock of 14.58 million tonnes this year, which means there is still an oversupply of the commodity in the market. Typically the industry is expected to carry a buffer stock of around 5 million tonnes on 1st October of any year as opening stock (www.indiansugar.com).

Problems faced by sugarcane farmers in Tamil Nadu

- The problems faced by the cane farmers in the cultivation process are ranked as follows: financial problem is the major constraint followed by high wage rate, labour shortage, high price of inputs, severity of diseases, water scarcity (drought), poor quality of inputs, climate condition, poor setts and lack of technology (Rama, 2018).
- While considering the problems faced by the growers in the marketing of sugarcane, in particular, delay in payment by the mills is the main problem and ranked as first. The State Advisory Price for sugarcane payable to farmers is due from the State government for more than a year. Besides there is no transparency in the weighing process, lower price of sugarcane, high cost of transport and lack of market information are some of the issues.
- On one side, the interest rate on loans borrowed by farmers is increasing, and on the other, the canes are drying up due to delay in cutting and crushing leads to a reduction in yield of sugarcane and thereby lower price for the agricultural produce.

- Sugarcane growers all over the country are facing enormous hardship. The Minimum Support Price for sugar cane as announced by the Union Government is inadequate and does not meet even the cost of production after putting in hard labour throughout.

Conclusion and Policy recommendation

As the state of Tamil Nadu has shown, even a smaller area under cultivation can produce high yields through better productivity. Thus by following a few best practices, even the existing acreage under sugarcane cultivation can be used to vastly improve India's sugar output. The most important recommendation is proper review of the government policy of MSP and this need to be increased. Farmers need to be supported not just with good prices, but also with appropriate technologies to improve yield so that the profits rise. Cane development staff and officers of the cooperative, public and private sector sugar mills should be trained in modern technologies. Subsidy for farmers should be given at the beginning of the financial year and should not be delayed. The sugar mill, run by the Tamil Nadu Sugar Corporation, is facing financial problems, which leads to delays and non-payment of cane dues to many farmers. The government must desilt and deepen all water bodies to store rainwater, must also construct community ponds for storing excess rainwater and check dams, barrages across rivers to regulate water flows.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Detection Methods of Seed Borne Pathogens

Article id: 22803

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INTRODUCTION:-

Seed is a small embryonic plant enclosed in a covering called seed coat. It is the product of the ripened ovule of gymnosperm and angiosperm plants which occurs after fertilization and some growth within the mother plant. Seed is the basic unit of production for the world's food crop. In recent years seed has become an international commodity used to exchange germplasm around the world. Seed is, however, also an efficient means of introducing plant pathogens into a new area as well as providing a means of their survival from one cropping season to another (Walcott *et al.,* 2006).

Seed-borne fungi are one of the most important biotic constrains in seed production worldwide. They are responsible for both pre and post-emergence death of grains, affect seedling vigour, and thus cause some reduction in germination and also variation in plant morphology (Niaz and Dawar, 2009).

Seed pathology involves the study and management of diseases affecting seed production and utilization, as well as disease management practices applied to seeds. In this presentation seed pathology are discussed: research innovations in detection of seed borne pathogens and elucidation of their epidemiology; advances in development and use of seed treatments; and progress toward standardization of phytosanitary regulations and seed health testing methods.

History:-

- **1755**- Tillet, a French botanist, showed that stinking smut or hill bunt of wheat was caused by poisonous substance on seed surface i.e. parasitic fungus.
- **1883**- Frank described the internally seed borne nature of a fungus in bean seed.
- **1892**- Beach, in New York, proved the seed borne nature of a bacterial pathogen *Xanthomonas axonopodis* pv. *phaseoli* in common bean.
- **1926**- First Seed Testing Laboratory is affiliated to International Seed Testing Association (ISTA).
- **1940**- Noble, coined the term "Seed Pathology".
- **1942**- Mayer, proved virus transmission through seed
- **2007**- H.S. Shetty, an outstanding Indian seed pathologist honoured with "Seed Health Award" for immense contribution in the area of seed health and seed quality control for developing countries.
- **Neergaard**, served as Director of the Danish Government Institute of Seed Pathology for Developing countries in Copenhagen.
- From 1956 to 1974 he served as the chairman of the Plant Disease Committee of the International Seed Testing Association (ISTA).
- During his tenure as chair of ISTA, he helped standardize methods for the detection of seed borne fungi.
- Neergaard authored a two-volume text book entitled "**Seed Pathology".**

Importance of Plant diseases

The studies of plant diseases are important as they cause loss to the produce. The various types of losses occur in the field, in storage or any time between sowing and consumption of produce. The diseases are responsible for direct monitory loss and material loss. Further, these diseases are harmful for the society as they cause stomach disorders, paralysis and liver diseases.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Hence, the diseases are required to be prevented and controlled to avoid loss of valuable food. The pathogen infects the soil and cause devaluation of land also. Causes of diseases a pathogen is always associated with disease. When the plant is suffering its functioning and development is disturbed, we call that as a diseased plant. Some reason which can define why plant diseases are important as follows;

Plant pests are still major constraints to food and agricultural production in parts of all regions of developing countries.
Crop losses significantly reduce food available for human and animal consumption food insecurity and poverty.
Negative effects in the internal and external marketing/trade in agricultural products, reduce farmer's income, and block poverty alleviation.
Control of plant pests still requires substantial use of pesticides (side effects on human health and the environment).

Seed borne diseases: - The establishment of a pathogen in, on and with the seed implies that the pathogen is seed borne. Seeds are attached by various fungi, bacteria and virus at different stages:-

- The mother plant get infected by the pathogen, it attack seed also.
- During processing.
- At the time of transportation.
- During storage

The seed borne pathogens may result in loss in germination, discolouration and shrivelling, development of plant diseases, distribution of pathogen to new areas, introduction of new strains or physiologic races of the pathogen along with new germplasm from other countries and toxin production in infected seed.

Impact of seed borne diseases:-

1. Reduction of Crop Yield
2. Seed borne pathogens are responsible for reduction of crop yield. Most important seed born disease is rice Blast (*Magnaporthe grisea*) was responsible for a famine in Japan during in 1930s. In Philippines, losses due to blast may be more than 50%. In 1942, the Bengal Famine in India was the failure of the rice crop because of brown spot (*Bipolaris oryzae*).
3. Loss of Germination & vigour
4. Many seed borne pathogen active when seeds are sown, which may result is failure of seed germination, seed decay and / or pre- or post-emergence damping-off and reduces seedling vigour.
5. Discoloration and shrivelling :
6. Discoloration can indicate undesirable physical qualities, some pathogen that cause discoloration in seeds affects seed coat colour, damage tissues in the seed coat and embryo.
7. Biochemical change
8. Many seed borne fungi causes quantitative change in the physio-chemical properties of seeds, such as colour, odour, oil content, iodine and saponification value and protein content.

Mechanism of Active Seed Infection

A. Direct Systemic infection via vascular system

Direct connection between embryonic & endospermic tissue becomes disconnected as seed develops.
Potential for transmission affected by degree of internal infection.
Many viruses, e.g.:

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Pea Seed-borne Mosaic Virus (PSBMV)
Lettuce mosaic virus (LMV)
Alfalfa mosaic virus (AMV)
Pea Early-Browning Virus (PEBV)

Some fungi, e.g.:
Vascular wilts (*Verticillium dahliae*, *Fusarium oxysporum*)
some downy mildews.

Few bacteria, e.g.:
*Xanthomonas campestris*pv. *Campestris*
Systemic infection via stigma to embryo

Pathogen moved from infected plants to flowers.
May follow pollen pathway to embryo sac.
Infected pollen may be less viable (poor fertilization).
Example:-
Pollen borne viruses – *Lettuce mosaic virus* (LMV)
Cucumber mosaic virus (CMV)
Nepoviruses (nematode transmitted polyhedral viruses)
Tobacco Ringspot Virus
Fungus- Loose smut fungi *(Ustilago tritici, Ustilago nuda)*

a. Systemic infection through flowers, fruits or funiculus

Most of the systemic seed-borne bacteria and fungus reach and infect the embryo through the flower or from the peduncle of the fruit, via funiculus.
Viruses go to the embryo from the systemically infected mother plant and the infected or contaminated pollen.
Weak necrotrophs:
- *Botrytis cinerea* -infected petals remain attached to developing fruit

Aggressive necrotrophs:
- Attack floral parts directly, e.g., *Ascochyta pisi, Alternaria brassicicola*

Fleshy fruits (e.g., *Solanaceae*) – seed attached to central placenta- infect via calyx - placenta – funicle – embryo.
Umbelliferae & *Liliaceae* – flowers exposed in umbels.

Seed Transmission of Seed Borne Pathogen

Transference of the seed borne pathogen and establishment of infection in plant(s) from the seed- this implies that the pathogen is **seed transmitted**. A seed borne pathogen may or may not be seed transmitted. It is a reasonable assumption that seed transmission is established scientifically for a pathogen only when any other means of transmission is excluded, such as transmission by air, soil, plant residues, vectors etc.

Seed borne organisms or viruses may be carried with seeds in principally two different ways:-

1. The seed may be *contaminated* (infested), i.e. the pathogen may be carried adhering to the surface of the seed, in fungi usually as spores; or the pathogen may be mixed with the seed, for instance as sclerotia, galls or as fruiting bodies inside or on the surface of plant debris.
2. The seed may be *infected*, the pathogen having penetrated into the tissues of the seed, and often established in a resting stage- fungi for instance as dormant mycelium.

Seed borne microorganisms are saprophytic, opportunistic and pathogenic; they are:-
fungi, bacteria, viruses, nematodes
Attributes of seed transmitted organism:-
Ability to gain access to seed
Ability to survive commercial processes- harvest, cleaning, treatment, storage.
Ability to establish on emerging seedlings- Primary or secondary transmission.

Seed Health Testing

Health of seed refers primarily to the presence or absence of disease-causing organisms, such as fungi, bacteria and viruses, and animal pests, including nematodes and insects, but physiological conditions such as trace element deficiency may be involved (ISTA, 2019).

Objective:-

Health testing of seed is important for four reasons:

1. Seed-borne inoculum may give rise to progressive disease development in the field and reduce the commercial value of the crop.
2. Imported seed lots may introduce diseases into new regions. Tests to meet quarantine requirements may therefore be necessary.
3. Seed health testing may elucidate seedling evaluation and causes of poor germination or field establishment and thus supplement germination testing.
4. Seed health test results can/may indicate the necessity to carry out/perform seed lot treatment(s) in order to eradicate seed-borne pathogens or to reduce the risk of disease transmission.

Sampling:-

Seed lot:-

A seed lot can be defined as a quantity of seed with every portion or every bag uniform within permitted tolerances as to percentage of pure seed, inert matter, other crop seed, germination and dormant seed, weed seed, and rate of occurrence of noxious weed seeds.

Working sample:-

From a submitted sample a reduce sample must be obtained for actual test is working sample.

Seed health testing to detect seed-borne pathogens is an important step in the management of crop diseases. It is a measure of freedom of seeds from pathogens. ISTA, ISHI and NSHS are three primary organizations that publish standardized seed health test methods. Specificity, sensitivity, speed, simplicity, cost effectiveness and reliability are main requirements for selection of seed health tests methods. Seed health is a well-recognized factor in the modern agricultural science for desired plant population and good harvest (Rahman *et al*., 2008).

Methods of seed health testing

Dry inspection method

Direct examination or inspection of dry seed is a qualitative and semi-quantitative seed health testing method where either the fruiting structures of fungi are detected under stereomicroscope or effects of fungal pathogens on the physical appearance of the seed are seen (Mathur and Jorgensen, 1998).

The seed sample is first examined by naked eyes, then under stereoscopic binocular microscope to record observation on the mixture of seeds, weed seeds, plant parts, inert matter, discoloration, malformations, sclerotia, galls, bunt balls, bacterial ooze, fungal bodies like acervuli, pycnidia, perithecia, hyphae, spore masses etc. Mechanical damage of seed is also recorded as they act suitable site for the entry of pathogen.

According to the rules of the International seed testing Association (ISTA), the inert matter fraction such as soil, sand and stones, various types of plant debris, including nematode galls, fungal bodies such as ergot sclerotia and smut balls, are of great pathological importance.

The inspection of dry seed in seed health testing is a qualitative test for which no standard working sample size has been worked out. However, it may be suggested to use a sample equal in size to the sample employed in the purity analysis in seed certification.

All parts of a seed sample are examined carefully by naked eye or with the help of hand lens. During the examination, emphasis is laid on galls, sclerotia and smut balls; the technique is simple and gives quick information about the health status of the seed lot.

- Microscopic examination of suspension obtained by

1. Washing test method :-

   This method is used particularly for smut and bunt fungi in gramineous hosts except loose smut of wheat and barley.

   E.g.: NAOH seed soak method – Applied for Karnal bunt of wheat and bunt of rice.

Procedure:-

a) Two g of seed is taken in a test tube with 10 ml of water and shaken for 10 minutes on a mechanical shaker.
b) The suspension is examined as such or the suspended spores are concentrated by centrifuging at 3000 rpm for 15-20 minutes.
c) The suspension is discarded and the spores are again suspended in 2 ml of lacto phenol (a mixture of lactic acid, phenol, water and glycerol in the ratio of 1:1:1:2).
d) This suspension is then examined under the microscope for the presence of spores, conidia and other fructifications.
e) Rice (1939) suggested the use of haemocytometer for the semi-quantitative estimation.

2. Whole embryo count method :-

Special method to separate the embryo has been devised by Hewett (1970) and Agarwal (1978). Staining methods are used for seed borne pathogens which cannot be detected by direct inspection or incubation methods. The standard method used in seed health testing is that of staining of barley embryos for the presence of loose smut (*Ustilago segetum* var. *tritici*) mycelium (Tsadaley B., 2015)

Procedure:

1. Soak 2000 seeds in 5 per cent sodium hydroxide solution containing 0.02 per cent try pan-blue for 24 h at room temperature (25-40°C).
2. Pass the soaked material through 10 mesh sieve and retain the material in a 20mesh sieve along with showers of tap water.
3. Collect the extracted embryos in a beaker.
4. Dehydrate the embryos in rectified spirit for 5-10 minutes.
5. Take the dehydrated embryos along with the chaff etc. in a beaker containing 50 ml solution of lactic acid and glycerol (1:1).
6. Add to above beakers 100 ml water and stir it.

7. Allow the material to stand for 5 minutes to settle the chaff at bottom.
8. Collect the floating embryos in another beaker containing 25ml fresh solution of lactic acid and glycerol (1:1).
9. Boil the above material for 2 minutes.
10. Pour the embryos in Petri dish and arrange in lines along with some solution of lactic acid and glycerol (1:1).
11. Observe the embryos under stereo binocular microscope for the presence of mycelium.
12. Mycelium appears as blue thread like knotted structure in the scutellum of the embryo.
13. Examine as far as possible all the extracted embryos.
14. Count the total number of embryos, including infected ones.
15. Calculate embryos and report the result of infection in percentage up to two decimal places and record the data.

Incubation test:-

1. Blotter method:-The blotter method was developed by Doyer in 1938 which was later included in the International seed Testing Association (ISTA) rules of 1966.

Procedure:

a) Three layers of blotters moistened with tap water are placed in Petri plates either of plastic or of Pyrex glass.
b) Usually 400 seeds/samples were taken.
c) 25 seeds in each Petri dish are placed following 15/16 seeds in the outer ring, 9/8 in the middle and one in the centre.
d) Incubate the dishes at 20-22°C for 7 days in alternating cycles of 12 hours darkness and 12 hours light.
e) After 7 days' incubation, start examination of seeds under a stereoscopic microscope.
f) Green pencils, which can write on wet blotters, should be preferred for making the observations.

2. **Agar Plate Method**:- In Northern Ireland Muskett and Malone (1941) first time used this method for seed health testing of flax seeds. Most commonly used media are Potato dextrose agar and Czeapak's dox agar.

Procedure:

a) Prepare P.D.A. medium.
b) Sterilize P.D.A. and Petri-plates.
c) Pour 20 ml P.D.A. medium in each Petri-plate.
d) Take 200 seeds at random.
e) Treat the seeds with 0.1% mercuric-chloride for two minutes.
f) Wash the seeds three times with sterilized water.
g) Place 10 seeds per plate at equal distance.
h) Incubate the plates at 28 ± 1°C with 12 hours alternating cycles of light and darkness.
i) Examine the plates after 8 days of incubation.
j) Note characteristics of fungal colonies from top and reverse.
k) Prepare the slides and examine them under compound microscope.
l) Record percentages of infection of different fungi.

3. **Deep Freezing Method:-**

Procedure:

a) Take 400 seeds at random.
b) Plate the seeds on moist blotters as per techniques described under blotter method.

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c) Incubate the plates in deep freeze at -20°C for 24 hours.
d) Again transfer the plates in original incubator under 12 hours light and darkness at 28°C for remaining 5 days.
e) Examine the seeds on 8th day.
f) Record the growth characters of the fungi as well as the percentage of infection.

4. Rolled Paper towel Method

The seeds are placed on moist paper towel and covered with another moist paper towel and rolled carefully. The rolled paper towels containing seeds are incubated in dark at suitable temperature for a fixed period of time. The seeds are examined after incubation for the presence of micro-organisms and germination. (This method is used for the detection of *Fusarium* spp. in cereals and Ascochyta diseases in pea).

5. **2, 4-D Method:** - The use of 2, 4-D in the blotter test was first introduced by Neergaard (1973) while testing cabbage seeds for *Phoma lingam*, although Hagborg (1950) first used it in agar medium for the detection of *Colletotrichum lindemuthianum* on bean seeds.

Procedure:

a) Instead of water the blotters are soaked in 0.2% solution of 2, 4-D (Dichlorophenoxy acetic acid).
b) Incubated the seed in incubation chamber at 28±1°C with cycles of 12 hours light and 12 hours darkness.
c) Examination of seed under stereoscopic binocular microscope at 50 x magnification after 8 hours.
d) Since 2, 4-D retards seed germination and seedling growth facilitating the examination quick and easy.

Seedling Symptom Test:-

1. **Hiltner's bricks stone method**: - It was developed by Hiltner in 1917. Sterile crushed brick stone with a maximum grain size of 3-4 mm is used filled in plastic pots up to ¾th of their capacity. The crushed brick stone in the pot is saturated with water and seeds are placed one cm deep.

   The pots are kept in darkness at room temperature and observations for disease symptoms are recorded after two weeks by removing the seedlings. It is a good method for filed performance test giving information on seedling symptoms. It is also used for testing treated seed.
2. **Sand Method**: - Similar to Hiltner's method except that instead of sterile crushed brick stone, sterilized sand is used.
3. **Standard Soil Method**:-A pre-sterilized uniform soil mixture containing 4 parts 03clay, 6 parts peat and essential amount of fertilizer is filled in plastic multi pot-trays. After planting the seed they are covered with a polyethylene bag to retain the moisture. The symptoms are observed after incubation for 2-4 weeks depending on the kind of seed and temperature. This method was by Karlberg (1974).

4. **Test Tube Agar Method**:-This method is developed by Khare, Mathur and Neergaard in 1977. It is used for the detection of *Septoria nodorum* in wheat grains.

Procedure:

a) 10 ml water agar is taken in each 16 mm diameter rimless test tube, sterilized and solidified with slight slant.
b) One seed is sown in each test tube.
c) The tubes are placed for incubation at 20°C under artificial day light tubes, 12/12 h cycle.
d) To retain moisture they are covered individually or in groups by a plastic sheet or aluminium foil which is removed when the seedlings have reached the cover.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

e) Seedlings are examined after 14 days for the typical symptoms of disease in the coleoptiles.
f) The symptoms can be easily studied being visible on roots as well as on green parts.
g) This method is useful for testing the efficiency of fungicides and also in quarantine stations as diseased seedlings of valuable crops can be destroyed and healthy one can be saved.

Serological tests:-

Serological seed assays rely on antibodies (polyclonal or monoclonal) generated against unique antigens on the surfaces of plant pathogens (Hampton *et al*., 1990). Serological methods used to detect and identify bacterial pathogens include agglutination tests, immunofluorescence microscopy (IF), immunofluorescence colony-staining (IFC), enzyme-linked immunosorbent assays (ELISA), Western blot, lateral flow devices (e.g., immunostrips), flow cytometry, and immunocapture techniques such as immunomagnetic separation (IMS) (Munkvold, 2009).

Growing on Test:-

Srinivasan (1973) developed a standardized method for detection of *Xanthomonas compestris* pv. *compestris* in seed sample of cauliflower.

Procedure:-

a) Seeds are soaked for 3-4 hours in a 20 ppm solution of Aurefungin (antifungal antibiotic), which is very effective against wide range of fungi including seed borne fungi.
b) Treated seeds are placed on plain agar plates (Bacto agar 1.5%) and plates are incubated at 20°C.
c) First observation is recorded after 8 days of incubation. The normal healthy seedlings grow rapidly, while diseased seeds show delayed germination and poor growth.
d) Emerging hypocotyls and Cotyledons appear yellowish and pulpy with the seedling collapsing on the agar surface.
e) The infected parts show prolific oozing of the bacteria as yellowish mass.
f) In infected seedlings V-shaped marginal lesions develop on emerging hypocotyls which show the bacterial ooze on microscopic examination.
g) Percentage of infected seedling is recorded by scanning the plates under the stereo binocular microscope.

Indicator Plant Test: - Main objective of this method is to produce symptoms on healthy seedlings or mature plants (Indicator plants) by using inoculum of infected or contaminated seeds. The inoculum from seeds slightly by *Xanthomonas compestris* pv. *phaseoli* when inoculated, to indicator plants by hypodermic injection gave more sensitive results than serological techniques.

Procedure:

a) Seeds are pre-treated in 2.6% sodium hypo chloride for 15 minutes and rinsed with sterile water.
b) Sample is incubated for 18-24 hours at room temperature after adding sterile water.
c) From the remainder of the liquid, injections are made into the Primary leaf node of 10 day old bean seedlings.
d) Appearance of large lesions followed by systemic necrosis is the positive reaction.

Electron Microscopy:-

Detection of various Formae Specialis of fungi is a challenge in seed pathology. The objective of this study to evaluate the application of standard SEM Methodology as an alternative to identify seed borne fungi in seeds submitted to the blotter test.

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PREVENTION OF SEED BORNE PATHOGEN

Avoidance and elimination of inoculum

- Quarantine procedure
- Eliminating source of inoculum:- utilisation of vertical resistance, elimination of collateral host , use of healthy certified seed.

Reduction of established inoculum

- In soil: - Irrigation, deep-ploughing, crop rotation, physical and chemical soil treatment.
- In collateral host and plant residues: - adjustment of soil cultivation, weed control.
- In seed :- seed processing (cleaning), seed storage, selection of seed lot (seed health testing), seed treatment

Slowing down the development and spread of inoculum

- Utilizing climatic difference :- selection of geographic location for seed production
- Influencing microclimate: - Planting site, seed variety, spacing, drainage.
- Impeding spread of inoculum: - utilization of horizontal resistance, control of vectors, planting date, distance between crops of same host range.

Improving conditions for plant development (reducing susceptibility)

- Proper growth place :- suitable production area or planting site
- Proper growth season :- Planting date
- Proper soil and plant management:- soil reactions, fertilizers, soil cultivation, preparation of seed bed.

SEED TREATMENT

According to International Seed Federation, Seed treatments are the biological, physical and chemical agents and techniques applied to seed to provide protection and improve the establishment of healthy crops.

Objective:-

1) To prevent germination failure, infection of seedling and subsequent crops by destroying externally contaminated and internally seed borne pathogen.
2) To prevent germinating seed or seedling from the attack of soil borne pathogen by developing a protective zone around the seed in soil.

CONCLUSION

1) Seed health is a well-recognized factor in the modern agricultural science for desired plant population and good harvest (Rahman *et al.,* 2008).
2) There are three primary organizations that publish standardized seed health test methods for use in international trade. These are International Seed Testing Association (ISTA), International Seed Health Initiative (ISHI), and in the United States, the National Seed Health System (NSHS) (Munkvold, 2009).
3) The molecular tools such as ELISA, PCR, DNA chips etc. have proved to be a powerful tool to study the microbial diversity of environmental samples

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Calyx End Softening: A new Melady in Flordasun Peach in Pantnagar condition

Article id: 22804

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INTRODUCTION

A new problem named calyx end softening is reported in peach cv. Flordasun at Horticultural Research Centre, Patharchatta, GBPUA & T, Pantnagar, U. S. Nagar, Uttarakhand. In this problem, the lower portion of the peach fruit (calyx end) remains soft upon ripening while the whole fruit appears to be normal, on the other hand, other cultivars *i.e.,* Shan-e-Punjab, Florida Prince, etc. remained unaffected. It was observed that the first flush of bloom or flowering was found to be unaffected whereas the fruits from the second flush were affected by this melady.

Effects of calyx end softening on fruits

1. **Reduced quality of the produce**
   As compared to the uninfected fruits, these fruits are poor in quality in terms of taste, appearance, palatability since the fruit tends to become watery and losses its quality and transportation.
2. **Less storage life**
   Since the fruit tends to become watery, hence the storage life reduces and fruits become unfit for consumption.
3. **More prone to the fungal infections**
   Due to the degradation of the sugars, the fruit tends to be watery hence the probability of the fungal infection is more in such kind of fruits. Hence fruits lose its texture, nutritive value and attractiveness.
4. **Loses transportation life**
   The affected fruits can't be transported for longer distance unlike other peach cultivars. Fruits of Flordasun harbors insect, pest and disease hence affect the other lot of quality fruits of other cultivars.

Possible causes of calyx end softening

1. **Application of excess irrigation water**
   If the water is provided during the second phase of flushing which exceeds its water requirement then there are chances of fruit quality degradation. This might be the reason for the breakdown of major sugars present in the fruits and made the fruit unpalatable.
2. **Contaminated air from industries**
   Polluted or, contaminated air coming out from the industrial area which is near to the peach orchard might be another region for the calyx end softening. The polluted air might have increased the ethylene level of the fruits which might have triggered the respiration process so quickly.

How to control this set back?

Melady was found to be less at some extent when irrigation was restricted or, stopped before second phase of the flowering. However, it did not give complete success in controlling this melady.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

CONCLUSION

The melady is novel in peach cv. Flordasun and makes whole orchard of this variety uneconomical since the fruit had lost the appearance, total soluble solids, acidity and firmness that could reflect in farmer's income. Another observation was that the other varieties in the field were performing well under same condition of soil and climate. The initial growth was normal however the fruits at developmental stages suffered a lot. Hence with this context, the manuscript also tried to elaborate the calyx end softening problems in fruits, especially in peach reported at GBPUA & T, Pantnagar and possible implications on economy and welfare of farmers throughout the country.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Disease resistance and molecular approach for disease management

Article id: 22805

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INTRODUCTION

Use of resistant varieties for plant is the cheapest, safest, simplest and effective method of plant disease control because it is economical environmentally friendly and easily for growers.

Use of resistant materials:

1. There use require no action by the grower during the growing period.
2. It is not disrupting to environment.
3. It is generally compatible with other disease management techniques.
4. It is sometimes similarly sufficient to suppress disease to tolerable levels.

What is resistance:

The ability of an organism to overcome effect of a pathogen or other damaging factor partly or completely or inherent capacity of a plant to suppress pathogen and disease development.

Limiting factors in usefulness of resistance:

Some pathogen populations have been remarkably adaptable and therefore have overcome the effects of resistance (breakdown of resistance). Some resistance have small effects.

Types of plants resistance to pathogen:

1. Non host resistance:

Resistance shown by a plant to one or more pathogen because of the plant is not host of pathogen. Non host are completely resistance to pathogens of other plants. Each kind of a plant is a non host to the vast majority of non plant pathogens. It is the most common and most effective form of plant defence that is microbes are unable to attack to plants. Eg. The resistance of peas to cowpea rust (*Uromyces phasioli* var. *vignae*) is non host resistance because no strains of this pathogen induce disease in peas.

2. True resistance:

It is also known as genetic resistance/ true resistance. True resistance is that plants which show resistance because they possess genes for resistance. It is controlled by genes located in plant chromosome in the cell nucleus. There are two kinds of true resistance one is vertical resistance and other is horizontal resistance. These are given by Vanderplank in 1963. Vanderplank is known as father of epidemiology. Its divided into two parts Vertical and Horizontal resistance.

Vertical resistance:

Resistance which is effective against some races of pathogen. It is controlled by single gene or very few genes. It is complete but permanent in nature (as any change in the race flora will make the host plant susceptible). It is generally not affected by environmental conditions. It is also known as race specific resistance/ major gene resistance/ monogenic resistance/ oligogenic resistance/ non durable resistance/ unstable resistance/ Qualitative resistance/ doomed to failure resistance/ seedling resistance/ overall resistance. It delays the onset of epidemic but does not slow down epidemic after it has started. Sometimes popularity of vertical resistance self destructive that is manmade epidemic. It is responsible for boom and bust cycle.

Horizontal resistance:

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Resistance which is effective against all races of pathogen is known as horizontal resistance. It is incomplete but permanent in nature. As some resistance in the host will always to be present to all the races of the pathogen. It is controlled by vary genes that is oligogenic in nature . It is more durable and does not failed by emergence by new race. It is generally effected by environmental conditions that is environmentally determined resistance. It is also known as race non specific/ non differential resistance/ rate reducing resistance/ environmentally altered resistance/ Partial resistance/ general or uniform resistance/ quantitive resistance/ durable resistance/ adult plant resistance/ minor or polygenic or multigenic resistance.

3. Apparent resistance :

In apparent resistance plants show resistance to their pathogen because of various reasons the escape or tolerant infection by these pathogens.

Disease escape:

Disease escapes occurs whenever genetically resistance plants does not become infected because of three factors necessary for disease (susceptible host, virulent pathogen and favorable environment)do not coincide and interact at proper time. For example plants may escape the disease if their seedlings become hard earlier than others and before the temperature terms favorable for pathogen.

Tolerance to disease:

Tolerance to disease is the ability of plants to produce a good crop even when they are infected with a pathogen. Tolerance results from specific heritable characteristic of the host plant. Generally tolerance plants produce a good crop when they are infected they produce an even better crop when they are not infected.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

ICT application tools for agricultural development in INDIA

Article id: 22806

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Agriculture is the backbone of Indian economy. It plays important role in economic and social development of country like India, where 58% of the people engaged in agriculture. Thus, Overall development of a country is not possible without agriculture. For growth of agriculture, it is important to disseminate the technology to the field. There are various methods to disseminate information to the field. ICT in agriculture is an emerging field focusing on the enhancement of agricultural and rural development in India. ICT is one of the important tool which provides the daily information to the farmers based on their need. Introduction of Information and Communication Technology (ICT) enables the dissemination of essential information to the famers at the right time. This revolution in information technology has made access to the information easy and cost-effective. Digitization is forming a digital version of analog/physical things such as paper documents, microfilm images, photographs, sounds and more. This digital information can be used by the farmers for various purposes based on their needs. Digitalization will play important role in agriculture innovation. Today, Information and Communication Technology can and should be a key agent for changing people's lives by improving access to information and sharing of knowledge. There are various ICT tools used in agriculture and some of them are given below:

- **Krishi: Knowledge based Resources Information Systems Hub for Innovations in agriculture** is an initiative of Indian Council of Agricultural Research (ICAR) to bring its knowledge resources to all stakeholders at one place. This portal acts as a Centralized data repository system of ICAR. It consists of technology, data generated through the experiments/surveys, publications and learning resources.
- **PGR Portal:** This portal is a gateway to information on plant genetic resources conserved in the Indian National Genebank housed at the National Bureau of Plant Genetic Resources (NBPGR). The Indian National Genebank conserves about 0.4 m accessions belonging to about 1800 species. The information which is provided by this portal is available to farmer, researcher, students and policy makers.
- **KrishiKosh:** is a digital repository system which accumulate knowledge in agriculture and allied sciences, having collection of old and valuable books, old journals, thesis, research articles, popular articles, monographs, catalogues, conference proceedings, success stories, case studies, annual reports, newsletters, pamphlets, brochures, bulletins and other literatures spread all over the country in different ICAR Research Institutions and State Agricultural Universities (SAUs).
- **RiceXpert:** it is a mobile app developed for the farmers to provide information to farmers in real time on insect pests, nutrients, weeds, nematodes and disease-related problems, rice varieties for different ecologies, farm implements for different field and post-harvest operations. This app facilitates the flow of information from farmer to the farm scientists and instantly provides the solution to the problems. Farmer can use this app to know about their queries instantly. This App may also be a very useful tool for the researchers, students and village level workers (VLWs) working on rice crop in different states as well as in the country.

- **Crop Insurance Mobile app:** This mobile app can be used to find out the complete details about the cover available, insurance premium under notified crops, coverage amount in case of loanee farmer. This scheme is extended by both public and private companies. States/UTs nominate insurance companies to extend insurance cover for different crops in districts/blocks. There is also a specific period during which farmers can avail this facility. Due to administrative and technical reasons much of this information is not able to reach to the farmers well in time to take advantage of these schemes. It can also be used to get details of normal sum insured, extended sum insured, premium details and subsidy information of any notified crop in any notified area.
- **Agri-Market Mobile App:** Farmers suffers from losses due to distress sales in the absence of proper information. This app is developed with the aim to provide the information on prices in the different markets to the farmers. AgriMarket Mobile App can be used to get the market price of crops in the markets within 50 km of the device's location. This app automatically captures the location by using mobile GPS and fetches the market prices of crops in different markets which are present in the vicinity of that area (50 km). There is another option to get price of any market and any crop in case person does not want to use GPS location. The prevailing prices are fetched from the Agmarknet portal.
- **mKishan Portal:** This portal is helpful to the farmer in providing the information/services to the farmers in agriculture and allied sectors through SMS in different languages.
- **Farmers' Portal: (One stop shop for farmers)** Farmers' Portal is an endeavour in this direction to create one stop shop for meeting all informational needs relating to Agriculture, Animal Husbandry and Fisheries sectors production, sale/storage of an Indian farmer. In farmers' portal farmers will get information on specific subjects of their village/block /state. The information is given to the farmers in the form of text, SMS, audio/video and through email in their language .Farmer will give valuable suggestion and feedback through feedback module.
- **mKRISHI:** This app is for aquaculture operations, providing digitally enables services on demand to the aqua farmers in the country. This portal is developed by the MPEDA. It provides the information related to wind speed, wave height, weather and best practices related to fisheries.
- **Epashuhaat:** It is a web portal launched by the Ministry of Agriculture and Farmers Welfare, Government of India, under the Department of Animal Husbandry, Dairying and Fisheries (DADF) to boost dairy productivity in India by organizing the livestock market. The portal allows farmers and entrepreneurs find information about bovine animals, buy or sell livestock, frozen semen and embryos. It also helps them to check information on feed and fodder and manage the transportation of animals once a purchase is made.
- **Kisan Point:** Kisan Point is market place for farmers and all other agriculture stake holders. Farmers can sell/buy/lease their land, crops, natural manures, cattle, used farm machinery *etc* using this trading platform. Farmers can also transparently buy inputs and implements using online shopping and ecommerce platform.
- **Pusa Krishi:** The app provide farmers with information related to new varieties of crops developed by Indian Council of Agriculture Research (ICAR), resource conserving cultivation practices as well as farm machinery and its implementation will help in increasing returns to farmers. It is developed by ICAR-IARI under the NEGP-A project of IT division of Department of Agriculture and Farmer Welfare to disseminate the information to the farmers, stakeholders and industrialists.
- **Farm-o-pedia:** The application is informative as well as can be used for daily routines. The app is useful for farmers or anyone related to agriculture. It is available in English and Gujarati languages. This app is targeted to rural Gujarat.

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- **Kisan Suvidha App:** Kisan Suvidha is an omnibus mobile app developed to help farmers by providing relevant information to them quickly. With click of a button, they can get the information on weather of current day and next 5 days, dealers, market prices, agro advisories, plant protection, IPM Practices *etc*. Unique features like extreme weather alerts and market prices of commodity in nearest area and the maximum price in state as well as India have been added to empower farmers in the best possible manner.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Pollen Culture: Meaning and Advantages

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Pollen Culture: Microspore or the immature pollen can be used as the explant to get the haploid plants directly. For pollen or microspore culture the flower buds are collected, surface sterilized and the anther lobes are dissected out from the flower buds as before. Then the anther lobes are squeezed with the help of a scalpel within a tube or small beaker to col-lect the microspore or pollen in nutrient media. Then the anther tissue debris is removed by filtering the suspension through a nylon sieve with a diameter slightly larger than the pollen size (40µ-100µ) allowing the microspore only to pass through it. Then the microspore-suspension washed and concentrated to a plating density. The microspores obtained are then mixed with an appropriate culture medium at a density of 103— 104 microspore/ml, and plated in small petriplate. To ensure good aeration, the layer of liquid in the dish should be as thin as possible, and sealed with 'parafilm' to avoid dehydration. The responsive pollen will divide and form embryos or calli which directly or indirectly will form the haploid plantlet. By following the method of sub-culturing the whole plant suitable for soil transfer can be obtained (Fig. 1).

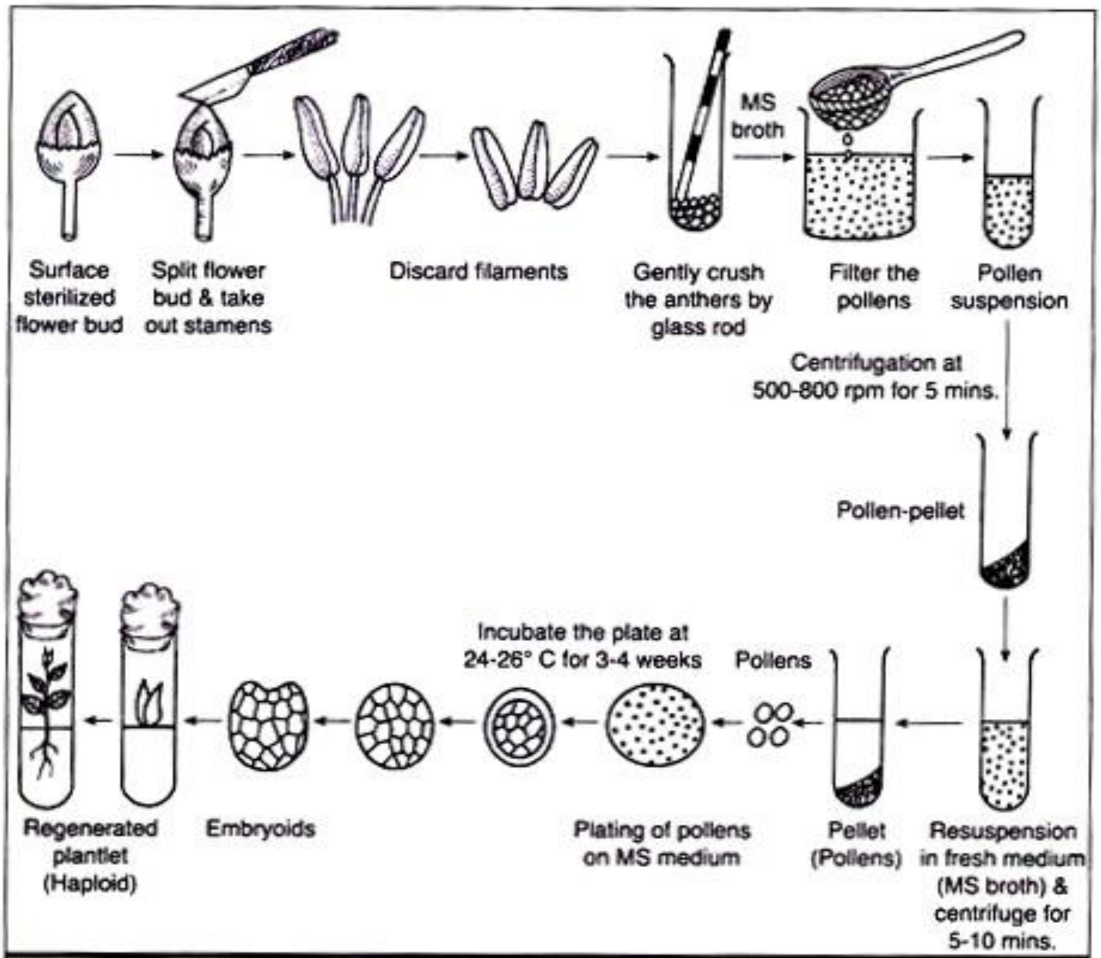

Fig. 21.3A: Pollen culture

Advantages of Pollen Culture:

The main disadvantage of anther culture is that the plants or embryos or calli not only originate from microspore or pollen but may also originate from various other parts of anther lobes (anther wall, nucellus, tapetum) which are diploid tissues. Furthermore, anther wall or other tissue may affect the way of androgenesis by inhibiting the penetrance of media or stimulating effect of hormones supplied. This difficulty can be avoided by culturing the isolated microspores or pollen. This method has the following advantages:

(i) The explants i.e., microspores or pollens are all haploid cells.
(ii) The sequence of androgenesis can be observed starting from a single cell.
(iii) The microspores are ideal for uptake, transformation and mutagenic studies, and the microspores are evenly exposed to chemicals and physical mutagens.
(iv) Higher yields of plants/anther could be obtained.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Plant Cell Vacuoles

Article id: 22808
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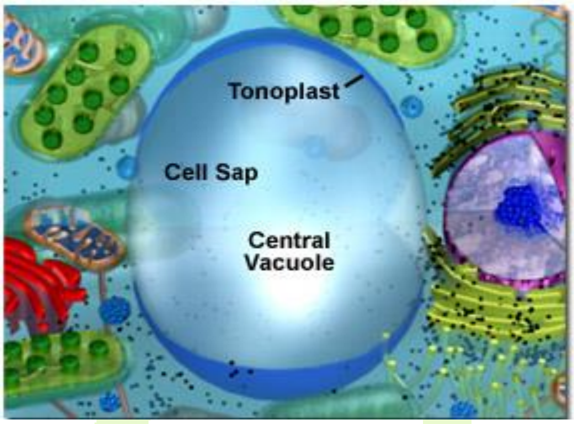
Vacuoles are membrane-bound sacs within the cytoplasm of a cell that function in several different ways. In mature plant cells, vacuoles tend to be very large and are extremely important in providing structural support, as well as serving functions such as storage, waste disposal, protection, and growth. Many plant cells have a large, single central vacuole that typically takes up most of the room in the cell (80 percent or more). Vacuoles in animal cells, however, tend to be much smaller, and are more commonly used to temporarily store materials or to transport substances.

Plant Cell Central Vacuole



The central vacuole in plant cells (see Figure 1) is enclosed by a membrane termed the tonoplast, an important and highly integrated component of the plant internal membrane network (endomembrane) system. This large vacuole slowly develops as the cell matures by fusion of smaller vacuoles derived from the endoplasmic reticulum and Golgi apparatus. Because the central vacuole is highly selective in transporting materials through its membrane, the chemical palette of the vacuole solution (termed the cell sap) differs markedly from that of the surrounding cytoplasm. For instance, some vacuoles contain pigments that give certain flowers their characteristic colors. The central vacuole also contains plant wastes that taste bitter to insects and animals, while developing seed cells use the central vacuole as a repository for protein storage.

Among its roles in plant cell function, the central vacuole stores salts, minerals, nutrients, proteins, pigments, helps in plant growth, and plays an important structural role for the plant. Under optimal conditions, the vacuoles are filled with water to the point that they exert a significant pressure against the cell wall. This helps maintain the structural integrity of the plant, along with the support from the cell wall, and enables the plant cell to grow much larger without having to synthesize new cytoplasm. In most cases, the plant cytoplasm is confined to a thin layer positioned between the plasma membrane and the tonoplast, yielding a large ratio of membrane surface to cytoplasm.

The structural importance of the plant vacuole is related to its ability to control turgor pressure. Turgor pressure dictates the rigidity of the cell and is associated with the difference between the osmotic pressure inside and outside of the cell. Osmotic pressure is the pressure required to prevent fluid diffusing through a semipermeable membrane separating two solutions containing different

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

concentrations of solute molecules. The response of plant cells to water is a prime example of the significance of turgor pressure. When a plant receives adequate amounts of water, the central vacuoles of its cells swell as the liquid collects within them, creating a high level of turgor pressure, which helps maintain the structural integrity of the plant, along with the support from the cell wall. In the absence of enough water, however, central vacuoles shrink and turgor pressure is reduced, compromising the plant's rigidity so that wilting takes place.

Plant vacuoles are also important for their role in molecular degradation and storage. Sometimes these functions are carried out by different vacuoles in the same cell, one serving as a compartment for breaking down materials (similar to the lysosomes found in animal cells), and another storing nutrients, waste products, or other substances. Several of the materials commonly stored in plant vacuoles have been found to be useful for humans, such as opium, rubber, and garlic flavoring, and are frequently harvested. Vacuoles also often store the pigments that give certain flowers their colors, which aid them in the attraction of bees and other pollinators, but also can release molecules that are poisonous, odoriferous, or unpalatable to various insects and animals, thus discouraging them from consuming the plant.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Micronutrients: Function, Deficiency and Control of Deficiency

Article id: 22809

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Plant nutrition is the study of the chemical elements and compounds necessary for plant growth, plant metabolism and their external supply.

1. In the absence of the nutrients plant is unable to complete a normal life cycle.
2. Or that the element is part of some essential plant constituent or metabolite.

There are seventeen most important nutrients for plants. Plants must obtain the mineral nutrients from their growing medium.

Micronutrients: These nutrients include minerals and vitamins. Unlike macronutrients, these are required in very minute amounts. There are 8 micro nutrients which are essential for plant growth as follows: Iron (Fe), Boron (B), Chlorine (Cl), Manganese (Mn), Zinc (Zn), Copper (Cu), Molybdenum (Mo), Nickel (Ni)

Functions of micronutrients in plants:-

Iron:

Functions:

(1) Helps in chlorophyll formation
(2) Acts as oxygen-carrier in oxidation- reduction reaction
(3) Helps in protein synthesis and several metabolic reactions.

Deficiency Symptoms:

The new leaves show chlorosis in between veins. The veins remain green.

Manganese:

Functions:

(1) Acts as a catalyst in oxidation-reduction reaction
(2) Acts as an activator of many enzymes
(3) Helps in chlorophyll synthesis.

Deficiency Symptoms:

(1) Small brown patches develop on leaves (Potato)
(2) In cotton, the upper leaves become yellowish-grey while veins remain green
(3) ‘Grey speck’ of Oat disease caused by manganese deficiency.

Boron:

Functions:

(1) Helps in the uptake of calcium
(2) Encourages efficient utilisation of calcium in plant

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(3) Helps in protein synthesis.

Deficiency Symptoms:
(1) The leaves thicken and margins roll upward
(2) The leaf tip and margin of older leaves die prematurely
(3) Terminal bud dies
(4) The younger leaves are dwarfed
(5) Diseases due to boron deficiency are: top rot of tobacco, heart rot of sugar beet, lack of head formation in cauliflower.

Copper:
Functions:
(1) Helps oxidation-reduction reaction
(2) It is a constituent of certain protein.

Deficiency Symptoms:
(1) In tobacco and potato, the young leaves remain permanently wilted
(2) The tip of the leave may turn white.

Molybdenum:
Functions:
(1) Helps in the fixation of atmospheric nitrogen in the roots of legume by nodule bacteria
(2) Helps in protein synthesis
Deficiency Symptoms:
(1) Curling of leaves
(2) Petiole of leaves remain intact but shedding of margin and other parts of leaves.

Zinc:
Functions:
(1) It is a constituent of a number of enzymes e.g. carbonic anhydrase, alcohol dehydrogenase, and various peptidases.
(2) Helps in the formation of growth hormones (auxines)
(3) Enhances heat and frost resistance of plant
(4) Affects the uptake of phosphorus by plants

(5) Acts as a catalyst in chlorophyll formation
(6) Deficiency of zinc in plant leads to reducing sucrose and starch content, decreasing auxin, upsetting protein synthesis and increasing organic acid content.

Deficiency Symptoms:
(1) Stunted growth
(2) Reddish-brown spots appear on lower leaves
(3) Later on the whole leaf becomes rusty brown in colour
(4) The mid rib of the younger leaves, especially at the base, become chlorotic
(5) Deficiency of zinc in rice is called ‘khaira disease’.

Control of Deficiency:

Iron:

Spraying of ferrous sulphate on foliage is an effective method in controlling its deficiency. Iron is trans-located very slowly, as a result, after spraying chlorotic- spots may still be in evidence in places which did not receive iron spray. On alkaline soils where iron chlorosis is common, application of iron compounds to the soil have not been very successful because iron is soon rendered insoluble.

Copper:

Copper sulphate is commonly used for the correction of deficiency of copper. It may be applied in soil or used as foliar spray. Solution of copper sulphate and calcium hydroxide is prepared in water for spraying. Without the calcium hydroxide, the copper sulphate injures the foliage.

Boron:

Boric acid or borax (sodium tetra borate) is used as a foliar spray. Boron is also satisfactorily applied to the soil, either alone or in mixed fertilizers.

Manganese:

Soil application of manganese sulphate was found effective. Spraying is economical since much smaller amount can be employed. The concentration used is 0.2-0.5 per cent manganese sulphate solution at the rate of 500- 1000 litre of water per hectare-. Manganese chloride solution may also be used in correcting the deficiency.

Molybdenum:

Sodium molybedate, ammonium molybedate are used in soil and spray application. Its translocation in plant is slow.

Zinc:

Mitigating the zinc deficiency is as follows:

In case of soil application method, 20 to 25 kg zinc sulphate per hectare is applied at the time of final land preparation. Its residual effect remains in the soil for 3-4 years.

Zinc sulphate is also applied in liquid form on foliage 5 kg zinc sulphate and 2.5 kg lime (calcium hydroxide) are dissolved in 1000 litre of water and spraying of this solution is done over standing crops.
Addition of organic matter to soil or growing green manure crops frequently improves crops subject to zinc deficiency.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Biology of *Apis mellifera* and Medicinal, Cosmetic Uses of Honey

Article id: 22810

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Kingdom: Animalia
Phylum: Arthropoda
Class: Insecta
Order: Hymenoptera
Family: Apidae
Genus: *Apis*
Species: *mellifera*

- **Structure:**
  The bodies of bees are divided into head, thorax and abdomen, with three pairs of legs and two pairs of wings on the thorax. The fore and hind wings on each side are linked by hooks and grooves so that they move together in flight. The mouth parts consist of a "tongue" or labium, which can be enclosed near the head by the labial palps and maxillae. Nectar, from the nectaries of flowers, can be drawn up the grooved surface of the labium, partly by capillary attraction and partly by the pumping action of muscles in the head. When not in use, these elongated mouth parts are folded back under the head, leaving the shorter, stouter mandibles free in front to chew pollen, manipulate wax, attack intruders etc. The ovipositor through which the queen lays her eggs in the wax cell, is modified in the workers to form a sting.

- *Apis mellifera is* commonly called as common honey bee or European honey bee. Body is golden brown and black, with pale orange/ yellow rings on abdomen. The head, antennae and legs are almost black, fine hairs cover the thorax and only lightly cover the abdomen. Wings are translucent (Arthur *et. al.,* 2003). *Apis mellifera* is about 1.2cm (about 0.5 inch) long, the head and thorax, or midsection, are somewhat bristly and vary in color according to the strain. Two large compound eyes and three simple eyes, or ocelli, are located on top of the head. Keen eyesight is complemented by two sensitive, odor-detecting antennae.

  - **Colony**

A colony of honey bees consist of a queen, several thousand workers, and, in certain seasons, a few hundred drones. A queen can lay as many as 2,000 eggs in a single day. In her four to five years she produces about two million eggs. More than 80,000 bees can live in a single colony (Arthur *et. al.,* 2003).

  - **Queen:**

Queens are the primary reproducers of the nest and all the activities of the colony are centered around their reproductive behaviors and their survival. The queen is the only fertile female in the colony. She lays eggs nearly continuously throughout the year, sometimes pausing in late fall in cold climates.

  - **Worker bee:**

Worker honey bees are infertile females, when some subspecies are stressed they may lay fertile eggs. Workers are essential for social structure and proper colony functioning. They carry out the main tasks of the colony, because the queen is occupied with only reproducing. They are the smallest in physical size of the three castes and their bodies are specialized for pollen and nectar collection. Both hind legs of a worker honey bee have a corbicula specially designed to carry large quantities of pollen back to the colony (Ashley *et. al.,* 2013).

- **Drones**

Drones are the male caste of honey bees. The drone‘s head and thorax are larger than those of the female castes, and their large eyes appear more fly-like, touching in the top centre of the head. Their abdomen is thick and blunt at the end, appearing bullet –shaped rather than pointy end as with the female castes (Ashley *et. al.,* 2013). Drone honey bees do not forage for nectar or pollen. Drones will mate with a given queen in flight; each will die immediately after mating, since the process of insemination requires a lethally convulsive effort.

- **Life cycle:**

The life cycle of the *Apis mellifera* consists of 4 stages, egg, larva, pupa and adult.

- **Egg**

Honey bee eggs measure 1 to 1.5 mm long and look like a tiny grain of rice. The queen lays eggs in individual hexagonal wax cells in the brood area of the comb (Ashley *et. al.,* 2013). Queen fertilizes each egg (with stored sperm from the spermatheca) as it is laid in a worker- sized cell. Eggs laid in drone-sized (larger) cells are left unfertilized; these unfertilized eggs, with half as many genes as queen or worker eggs, develop into drones.

- **Larva**

In the honey bee colony, larvae are referred to as open brood because the cells are uncapped. The number of days a honey bee spends as larvae varies by caste (worker: 6 days, drone: 6.5 days, queen: 5.5 days). Larvae are white and lie in a curled C shape at the bottom of their wax cell. When the mature larvae are ready to moult into pupae they extend their bodies into an upright position in the cell, and adult workers tending to the brood cover the pre-pupal larvae with a wax capping (Ashley *et. al.,* 2013).

- **Pupa**

Beneath the wax capping, pre-pupal honey bee larvae moult into pupae. The pupae remain under the wax capping until they moult into an adult and chew their way out of the cell. Similar to the larval stage, pupal developmental time varies by caste (worker: 12 days, drone: 14.5 days, queen: 8 days) (Ashley *et. al.,* 2013). The larvae and pupae in a frame of honeycomb are known as "frames of brood", and are sold (with adhering bees) to start new beehives.

- **Adult**

Adult honey bees are covered in branched hairs and can be divided into three body regions: head, thorax, and abdomen. The primary features of the head are the compound eyes and antennae. The most notable external feature of the abdomen is the stinger. Only female honey bees have a stinger, as it originates from a modified ovipositor (Ashley *et. al.,* 2013).

Medicinal uses of honey:

Bee’s honey is used in treatment of various ailments and as a popular home remedy. Some of these uses are given below:

1. Stress / fatigue: 15 ml of bee’s honey orally to reduce stress and fatigue.
2. Weakness: 15 ml each of bee’s honey and fruit juice of *Punica granatum* twice a day before meals.
3. Sleep disturbance: Intake of 15 ml of bee’s honey leads to sound sleep.
4. Eyesight: 10 ml of honey mixed with 10 ml of carrot juice and consumed regularly will improve eyesight.
5. Bad breath: 5 g of powdered cinnamon bark and 5ml of bee’s honey mixed with water and use as a mouth wash.
6. Teething pain: Massage gums gently with bee’s honey. Should not use in children below one year.

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7. Sore throat: 5 ml of bee's honey and 10 ml of lime juice is mixed and given. Swallow the concoction (without water) every few hours until symptoms clear up. Add a pinch of black pepper to increase blood circulation to the throat.
8. Cold and cough: Mix 10 ml of honey with equal quantity of ginger juice and consume twice a day.
9. Bronchial asthma: A mixture of 2.5g of black pepper powder, 5ml each of honey and juice of ginger consumed thrice daily help to relieve the symptoms of asthma.
10. Hiccough: 5 ml of bee's honey is mixed with 10 ml of breast milk. Nasya Karma (nasal douche) is performed with this mixture in treatment of hiccough. This is used by traditional physicians of Sri Lanka.
11. Stomach ulcers: 5 ml of new bee's honey diluted in 10 ml of water and given twice a day before meals.
12. Vomiting: 2.5g each of powder of fruit of *Piper longum* and popped rice is ground with 15ml of bee's honey and given orally as an antiemetic.
13. Dehydration: Fresh bee's honey diluted in water is given to rehydrate.
14. Diarrhea: Drink 5 ml of old bee's honey thrice a day before meals.
15. Diarrhea/Dysentery: 15 ml of bee's honey mixed with 120 ml of decoction of tubers of *Cyperus rotundus* is given in treatment of diarrhea and dysentery.
16. Bed-wetting: Give 5ml of old bee's honey daily just before going to bed.
17. Polyuria: 5 ml of bee's honey, 20 ml of fresh juice of fruits of *Phyllanthus emblica* and 6g of pulp of *P. emblica* are mixed together and consumed twice a day.
18. Diabetes mellitus: 5 ml of bee's honey mixed with a pinch of powdered seeds of *Gossypium herbaceum* and is given to reduce blood sugar in diabetic patients.
19. Hypertension: Daily intake of 10 ml of honey mixed with 5 ml of garlic juice helps to control blood pressure.
20. Hemiplegia: 240 ml of bee's honey is dissolved in 960 ml of water and is boiled down to total volume of 960 ml. In Unani system of Medicine, this is known as Mavul Asal. 30ml of this is given twice a day during early stages of hemiplegia. This prescribed for patient suffering from hemiplegia at Ayurveda Teaching Hospital, Borella, Sri Lanka.
21. Obesity: Keep garlic immersed in bee's honey for one year. Then, use 1 clove of garlic daily before breakfast. This is used as a home remedy. One glass of warm water taken with 10 ml of honey and 5 ml of lemon juice in early morning reduces fat and purifies blood.
22. Arthritis: 30 ml each of bee's honey and coconut vinegar is mixed in 100ml of water and given twice a day to reduce arthritis and arthralgia.
23. Burns: Apply fresh bee's honey directly.
24. Cut and wounds: Apply bee's honey on cuts and wounds.
25. Eczema: Apply fresh bee's honey on the lesion.
26. Dermatitis: Bee's honey is mixed with ash obtained by burning stem of *Pterocarpus santalinus* and applied on the lesion.
27. Allergies due to seasons: Bee's honey should be collected from the area where the patient lives. 5ml of this honey is to be given daily before breakfast.
28. Sub fertility due to lack of semen: Add 5 ml of bee's honey to a glass of goat's milk and drink.
29. Morning sickness: 15 ml of bee's honey before breakfast.
30. Relief from hangover: Mix 10ml of bee's honey with half a cup of orange juice and half a cup yogurt. Blend them together properly and drink.
31. Jaundice, bleeding disorders: 15ml of bee's honey mixed with 120 ml of fresh juice of *Adhathoda vasica*, is given twice a day in treatment of jaundice and bleeding disorders. (60g each of fresh leaves and flowers of *A. vasica* are taken, pounded well, and fresh juice is extracted after adding 100 ml of water).

32. Burning sensation in the body and thirst: Unpolished rice is washed with water and 100ml of this water is taken. 15 ml of bee's honey, 5g of sugar and 10g of powder of stem of *Santalum album* are added to this and mixed well. This mixture is given twice a day after meals.

Cosmetic uses of honey:

Honey and beeswax are used in the beauty industry as a skin moisturizer, softener and to heal the skin tissue. Some cosmetic applications of bee's honey are given below:

1. Face wash: Mix a small quantity of lemon juice into 5ml of bee's honey and apply on face before washing. This is used as a home remedy.

2. Facial cleansing scrub: Mix 5g of almond seed powder into 5ml of bee's honey, scrub softly and then wash.

3. Facial to improve smoothness: A tablespoon of honey whisked together with white of an egg, 1 teaspoon of glycerin and 1/4 cup of flour makes an excellent firming mask. Just smooth on the face, leave on 15 min, and rinse off with warm water.

4. Facial to improve softness: Mix one or two tablespoons of honey with one-third cup finely ground oatmeal. Add a teaspoonful of rose water. Clean face thoroughly. Spread facial mixture evenly over face. Relax for 10 min to 1.5 h. Remove with a soft washcloth and warm water. Rinse with cold water.

5. Facial moisturizing pack: Mix 2 tablespoons of honey with 2 teaspoons of whole milk. Apply over the face and keep for 15 min. Rinse off with warm water, and then with cold water.[9]

6. Pimples: Apply bee's honey on pimples.

7. Cracked lips: Apply bee's honey on cracked lips.

8. Lotion for dry patches of skin: Mix 5ml of bee's honey, 5ml of olive oil and 2.5 ml of lemon juice. Apply on skin and wash after 15 min.

9. Hair lusters: Mix 5ml of bee's honey into 4 cups of warm water. Use as a hair rinse.

10. Conditioner: Mix 10 ml of olive oil into 5ml of bee's honey and apply on hair. Wash after 15 min.

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Food Fortification: Health Approach for Micro-nutrients security

Article id: 22811

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Micro-nutrient deficiencies are major public health problems that affect all segments of the population both in developed and developing countries. Six decades ago India had recognized that iodine deficiency resulting in cretinism and goitre, Vitamin A deficiency leading to blindness in young children and iron and folic acid deficiency resulting in anaemia with adverse health consequences to the mother child dyad were major public health problems. The country embarked on intervention programmes to combat these deficiencies through dietary diversification, micro-nutrient supplementation and food fortification. The National Goitre Control Programme (NGCP) initiated in 1962 was the first food fortification programme to combat iodine deficiency disorders. During the initial three decades, coverage under the programme was very low. But in 2006, National Family Health Survey (NFHS) reported that household use of iodised salt was only 50% (NFHS-3 2006). In 2007, the Government of India mandated that only iodised salt should be made available for human consumption. During the next decade, there was a steep increase in household access to iodised salt. Currently, over 90% of households use iodised salt (NFHS-4 2015).

Through the fortification of appropriate food stuffs, it is possible to increase the intake of specific micro-nutrients without any dietary modification and sustain it over a long period of time, so that there is progressive reduction in micro-nutrient deficiencies at population level. Food fortification has become a viable, sustainable, effective and relatively inexpensive strategy to combat widespread micro-nutrient deficiencies. But care has to be taken to ensure that the technology is not used to fortify multiple food stuffs with multiple micro-nutrients because excessive intake of nutrients or imbalance between nutrients can have adverse health consequences.

Food Security and Food Fortification

Global and Indian experience has shown that dietary diversification and nutrition education are the two long term sustainable methods for the prevention of micronutrient deficiencies, ensuring that “all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO 1996).

The three-pronged strategy for combating micro-nutrient deficiencies, includes dietary diversification, nutrient supplementation and food fortification. Nutrition education aimed at improving dietary diversification and increased intake of vegetables rich in micro-nutrient content is an important component of all nutritional interventions. But it can succeed (especially among the poorer segments of population) only when vegetables are available throughout the year at an affordable cost. Interventions under the National Horticultural Mission (NHM 2016) have led to a substantial increase in vegetable production in the last decade. However, per capita consumption still remains low, partly because of bottlenecks in access and partly because of the high cost of the vegetables. Supplementation programmes to combat anaemia and vitamin A deficiency both in India and elsewhere, have shown that it is difficult to sustain long-term nutrient supplementation programmes for large population groups. Given these circumstances food fortification may be an effective, inexpensive and sustainable measure for combating widespread micro-nutrient deficiencies especially among the poorer segmentsof population.

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Types of Food Fortification

There are three major categories of food fortification:

(a) Fortification as a public health intervention to bridge the gap in nutrient intake across population groups.

(b) Targeted food fortification aimed at bridging the nutrient gaps in specific "at risk" population groups with nutrient deficiencies.

(c) Market driven fortification aimed at increasing product appeal without nutritional rationale.

Public Health Food Fortification

Involves identifying micro-nutrient deficiencies of public health importance and evolving and evaluating appropriate technologies for fortification of widely consumed food stuffs with these micro-nutrients. Food stuff that are to be fortified for public health intervention and the amount of the nutrient used for fortification should be chosen with care because the product may be widely used by large segments of population, who may continue to take the fortified food for long periods of time without adequate monitoring, supervision or evaluation. Initiating public health food fortification programmes is a long and sometimes very tedious process. Major steps to be followed in the process include:

- Obtaining data on the intake of each nutrient in specific population groups and identifying the proportion of the population in whom intake is inadequate
- Identifying nutritional deficiencies of public health importance
- Identifying the most commonly consumed food stuffs in the population and amount of the food stuff consumed daily.
- Determining the amount of nutrient to be added to the food stuff for fortification.
- Evolving appropriate technologies for fortifying the chosen food stuff with the chosen micronutrient, and assessing safety and efficacy of the fortified product.
- Undertaking studies to assess the organoleptic properties, acceptability and use effectiveness of fortified food stuff.
- Assessing the feasibility of scaling up production and working out the cost of expanding the fortification programme.
- Scaling up production and improving access to the fortified food, beginning with vulnerable segments of population who are receiving food supplements; widening access in a phased manner through Public Distribution System (PDS) and then the open market

Ideally, the food stuff should be fortified with the selected nutrient to a level which meets all the following criteria:

- Daily consumption (of the fortified food plus other regular food) meets the requirement of the nutrient in those with low intake.
- The total intake of the nutrient is not much higher than Recommended Dietary Allowance (RDA) for that nutrient and the total intake is substantially lower than Tolerable Upper Limit (TUL) for those with adequate intake from their regular food alone.

Mandatory Fortification

It is considered only in those rare occasions when there is a major public health problem due to micronutrient deficiency, across all segments of the population, which cannot be tackled through a foodbased approach. In the Indian context iodine and iron qualify under these stringent criteria. Adequate production, transport and marketing of the fortified food should be ensured before considering

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

mandatory fortification. Over four decades have elapsed between the initiation of National Goitre Control Programme (1962) and implementation of mandatory fortification of salt with iodine (2007).

Targeted Food Fortification

It has been used mainly to combat micro-nutrient deficiencies in specific groups such as infants and young children (who do not consume adequate micronutrients) by fortifying complementary foods with one or more micro-nutrients that are deficient in the food.

Market-driven Fortification

It is the fortification of several food stuffs often with multiple micro-nutrients without any specific nutritional rationale. This is being done mainly to increase the market share of the product by claiming nutritional and health benefits, so that segments of the population who are health conscious but perhaps not nutritionally well-informed may purchase and use these products.

CONCLUSION

Micro-nutrient deficiencies, especially those of iodine, iron, folate, vitamin B 12, vitamin A and vitamin D are major public health problems in many segments of the population in India. Through fortification of appropriate food stuff, it is possible to achieve sustained improvement in the intake of these micro-nutrients and reduction in micro-nutrient deficiencies at the population level. India's effort to eliminate IDD through universal salt iodisation has resulted in over 90% of households using iodised salt and a steep decline in IDD. Food fortification does represent a sustainable method of increasing the population's intake for selected micro-nutrients. However, fortification of multiple food stuff with multiple micro-nutrients is not advisable because of the potential adverse health consequences of excessive intake of some micronutrients and/or imbalance of intake of inter-related micro-nutrients by segments of the population who are already consuming one or more of these nutrients in sufficient amount in their daily diets.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Apparatus Used for Plant Protection (Plant Pathology, Entomology, Nematology) Work

Article id: 22812

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Optical microscope

A modern microscope with a mercury bulb for fluorescence microscopy. The microscope has a digital camera, and is attached to a computer. The optical microscope, often referred to as light microscope, is a type of microscope which uses visible light and a system of lenses to magnify images of small samples. Optical microscopes are the oldest design of microscope and were possibly invented in their present compound form in the 17th century. Basic optical
microscopes can be very simple, although there are many complex designs which aim to improve resolution and sample contrast.

Simple microscope

A simple microscope is a microscope that uses a lens or set of lenses to enlarge an object through angular magnification alone, giving the viewer an erect enlarged virtual image. Simple microscopes are not capable of high magnification. The use of a single convex lens or groups of lenses are still found in simple magnification devices such as the magnifying glass, loupes, and eyepieces for telescopes and microscopes.

Compound microscope

A compound microscope is a microscope which uses a lens close to the object being viewed to collect light (called the objective lens) which focuses a real image of the object inside the microscope. That image is then magnified by a second lens or group of lenses (called the eyepiece) that gives the viewer an enlarged inverted virtual image of the object. The use of a compound objective/eyepiece combination allows for much higher magnification, reduced chromatic aberration and exchangeable objective lenses to adjust the magnification. A compound microscope also enables more advanced illumination setups, such as phase contrast.

History

Invention

It is difficult to say who invented the compound microscope. The Dutch spectacle-maker Zacharias Janssen is sometimes claimed to have invented it in 1590 (a claim made by his son and fellow countrymen, in different testimony in 1634 and 1655). Another claim is that Janssen's competitor, Hans Lippershey, invented the compound microscope. Another favorite for the title of 'inventor of the microscope' was Galileo Galileo. He developed an occhiolino or compound microscope with a convex and a concave lens in 1609. Galileo's microscope was celebrated in the Accademia dei Lincei in 1624 and was the first such device to be given the name "microscope" a year later by fellow Lincean Giovanni Faber. Faber coined the name from the Greek words ieenui (micron) meaning "small", and oeidai (skopein) meaning "to look at", a name meant to be analogous with "telescope", another word coined by the Linceans. Christiaan Huygens, another Dutchman, developed a simple 2-lens ocular system in the late 17th century that was achromatically corrected, and therefore a huge step forward in microscope development. The Huygens ocular is still being produced to this day, but suffers from a small field size, and other minor disadvantages.

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Popularization

Antonie van Leeuwenhoek (1632–1724) is credited with bringing the microscope to the attention of biologists, even though simple magnifying lenses were already being produced in the 16th century. Van Leeuwenhoek's home-made microscopes were simple microscopes, with a single very small, yet strong lens. They were awkward in use, but enabled van Leeuwenhoek to see detailed images. It took about 150 years of optical development before the compound microscope was able to provide the same quality image as van Leeuwenhoek's simple microscopes, due to difficulties in configuring multiple lenses.

Lighting techniques

While basic microscope technology and optics have been available for over 400 years it is much more recently that techniques in sample illumination were developed to generate the high quality images seen today. In August 1893 August Kohler developed Kohler illumination. This method of sample illumination gives rise to extremely even lighting and overcomes many limitations of older techniques of sample illumination. Before development of Kohler illumination the image of the light source, for example a lightbulb filament was always visible in the image of the sample. The Nobel Prize in physics was awarded to Dutch physicist Frits Zernike in 1953 for his development of phase contrastillumination which allows imaging of transparent samples. By using interference rather than absorption of light, extremely transparent samples, such as live mammalian cells, can be imaged without having to use staining techniques. Just two years later, in 1955, Georges Nomarski published the theory for differential interference contrast microscopy, another interference-based imaging technique.

Fluorescence microscopy

Modern biological microscopy depends heavily on the development of fluorescent probes for specific structures within a cell. In contrast to normal transilluminated light microscopy, in fluorescence microscopy the sample is illuminated through the objective lens with a narrow set of wavelengths of light. This light interacts with fluorophores in the sample which then emit light of a longer wavelength. It is this emitted light which makes up the image. Since the mid 20th century chemical fluorescent stains, such as DAPI which binds to DNA, have been used to label specific structures within the cell. More recent developments include immunofluorescence, which uses fluorescently labelled antibodies to recognise specific proteins within a sample, and fluorescent proteins likeGFP which a live cell can express making it fluorescent.

Eyepiece (ocular lens)

The eyepiece, or ocular lens, is a cylinder containing two or more lenses; its function is to bring the image into focus for the eye. The eyepiece is inserted into the top end of the body tube. Eyepieces are interchangeable and many different eyepieces can be inserted with different degrees of magnification. Typical magnification values for eyepieces include 5×, 10× (the most common), 15X and 20×. In some high performance microscopes,

the optical configuration of the objective lens and eyepiece are matched to give the best possible optical performance. This occurs most commonly with apochromatic objectives.

Objective turret (revolver or revolving nose piece) Objective turret, revolver, or revolving nose piece is the part that holds the set of objective lenses. It allows the user to switch

between objective lenses.

Objective

At the lower end of a typical compound optical microscope, there are one or more objective lenses that collect light from the sample. The objective is usually in a cylinder housing containing a glass single or multi-element compound lens. Typically there will be around three objective lenses screwed into a circular nose piece which may be rotated to select the required objective lens. These arrangements are designed to be parfocal, which means that when one changes from one lens to another on a microscope, the sample stays in focus. Microscope objectives are characterized by two parameters, namely, magnification and numerical aperture. The former typically ranges from 5× to 100× while the latter ranges from 0.14 to 0.7, corresponding to focal lengths of about 40 to 2 mm, respectively. Objective lenses with higher magnifications normally have a higher numerical aperture and a shorter depth of field in the resulting image. Some high performance objective lenses may require matched eyepieces to deliver the best optical performance.

Oil immersion objective

Some microscopes make use of oil-immersion objectives or water-immersion objectives for greater resolution at high magnification. These are used with index-matching material such
as immersion oil or water and a matched cover slip between the objective lens and the sample. The refractive index of the index matching material is higher than air allowing the objective lens to have a larger numerical aperture (greater than 1) so that the light is transmitted from the specimen to the outer face of the objective lens with minimal refraction. Numerical apertures as high as 1.6 can be achieved. The larger numerical aperture allows
collection of more light making detailed observation of smaller details possible. An oil immersion lens usually has a magnification of 40 to 100×.

Focus knobs

Adjustment knobs move the stage up and down with separate adjustment for coarse and fine focusing. The same controls enable the microscope to adjust to specimens of different thickness. In older designs of microscopes, the focus adjustment wheels move the microscope tube up or down relative to the stand and had a fixed stage.

Frame

The whole of the optical assembly is traditionally attached to a rigid arm, which in turn is attached to a robust U-shaped foot to provide the necessary rigidity. The arm angle may be adjustable to allow the viewing angle to be adjusted. The frame provides a mounting point for various microscope controls. Normally this will include controls for focusing, typically a large knurled wheel to adjust coarse focus, together with a smaller knurled wheel to control fine focus. Other features may be lamp controls and/or controls for adjusting the condenser.

Stage

The stage is a platform below the objective which supports the specimen being viewed. In the center of the stage is a hole through which light passes to illuminate the specimen. The stage usually has arms to hold slides (rectangular glass plates with typical dimensions of 25×75 mm, on which the specimen is mounted).

At magnifications higher than 100× moving a slide by hand is not practical. A mechanical stage, typical of medium and higher priced microscopes, allows tiny movements of the slide via control knobs that reposition the sample/slide as desired. If a microscope did not originally have a mechanical stage it may be possible to add one.

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All stages move up and down for focus. With a mechanical stage slides move on two horizontal axes for positioning the specimen to examine specimen details.
Focusing starts at lower magnification in order to center the specimen by the user on the stage. Moving to a higher magnification requires the stage to be moved higher vertically for
re-focus at the higher magnification and may also require slight horizontal specimen position adjustment. Horizontal specimen position adjustments are the reason for having a mechanical stage. Due to the difficulty in preparing specimens and mounting them on slides, for children it's best to begin with prepared slides that are centered and focus easily regardless of the focus level used.

Light source

Many sources of light can be used. At its simplest, daylight is directed via a mirror. Most microscopes, however, have their own adjustable and controllable light source – often a halogen lamp, although illumination using LEDs and lasers are becoming a more common provision.

Condenser

The condenser is a lens designed to focus light from the illumination source onto the sample. The condenser may also include other features, such as a diaphragmand/or filters, to
manage the quality and intensity of the illumination. For illumination techniques like dark field, phase contrast and differential interference contrast microscopy additional optical
components must be precisely aligned in the light path.

Magnification

The actual power or magnification of a compound optical microscope is the product of the powers of the ocular (eyepiece) and the objective lens. The maximum normal magnifications of the ocular and objective are 10× and 100× respectively, giving a final magnification of 1,000×

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

PINEAPPLE (*Ananas sativus*): Its importance and management

Article id: 22813

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Climate

It is tropical fruit crop. It thrives well in a mild tropical climate. It grows well near the coast as well in the interior so long as the temperatures are not extreme. The optimum temperature ranges from 21 – 23^{O} C. It can be grown upto an elevation of 1100m above the sea level, provided they are free from frost. It requires an optimum of 150 cm which should be well distributed. Where the rainfall is less, supplementary irrigation must be provided.

Soils

Pineapple can be grown on any type of soil (expect heavy clay). However, sandy loam with a pH range of 5.5 to 6.0 is the best. The soil should have a depth of atleast 60 cm without hard pan beneath or water logging. Low lying areas with high water table are not suitable.

Varieties

- **Kew**

It is a leading commercial variety of India. It is the most suitable variety for canning. It is a prolific yielder. Fruits are large and each fruit weighs 1.5 to 2.5 kg. The eyes on the fruits are broad and shallow. The external colour of the ripe fruit is yellow. The flesh is firm, juicy and pale yellow in colour. It has almost spineless leaves. The variety is of shy suckering habit. This variety is grown in Tamil Nadu. It is a late maturing variety, ripening in August and September.

- **Queen**

This is an early variety, earliest of all the varieties in Indai, ripens in June-July with a a very uniform ripening habit. The fruit cylindrical and of medium in size and weighs 0.5 to 1.0 kg. Eyes are prominent and deep, hence not suitable for canning. Queen is the best desert pineapple. The external colour of the ripe fruit is deep yellow. The flesh is firm, crisp, sweet and golden yellow in colour. As compared to Kew, Queen plants are smaller with a dwarf and compact habit of growth. They have spiny serrated leaf margins. It produces suckers freely.

- **Mauritius**

This is a mid season variety ripening in July-August. Fruits are of medium size, weighing about 2-3 kg on an average. The fruit may be oblong or round in shape. External colour of the ripe fruit is reddish yellow. The flesh is light yellow in colour and slightly fibrous. The plants of this variety resemble Queen plants in most of the vegetative and fruit characters. The leaves are serrated and spiny.

- **Simhachalam**

This is a local variety, largely grown in Visakhapatnam area. Fruits are small and flesh is light yellow with fibre.

Propagation

Pineapple is propagated vegetatively through suckers, slips and crowns. Suckers are shoots arising from the axils of the leaves of from the base of plant near the ground. Slips are produced on the fruiting stem while crowns are borne on the top of the fruit. Suckers and slips are generally used, because suckers give the first crop in 14 to 18 months. Slips take 20-22 months for the first crop, while crowns take more than 24 months for the first crop. Because of shy suckering habit or Kew variety, crowns are used as propagating material in Kew variety.

Planting

Suckers of uniform size (400-450g) should be selected for planting, as they give best yields compared to higher or lower size categories of suckers. Planting materials should be collected from high yielding well maintained gardens, which are free from pests and diseases.

At the time of planting, few basal scale leaves of the suckers should be stripped off to encourage the formation and entry of roots into the soil. Before planting, the sucker should be dried for one of two days, by spreading them upside down. Fresh suckers should not be planted in moist soil, otherwise they decay. The suckers should be dipped in Bordeaux mixture (1%) or Dithane Z-78 (0.3%) and Difolatan (0.2%) to avoid mealy bugs and heart rot.

Planting may be done normally during the rainy season, avoiding periods of heavy rainfall. July and August are the best months, however, where irrigation facilities are available, planting can be taken up alround the year to ensure supply of fruits throughout the year.

The popular method of planting pineapple is the double row system. The two rows are spaced 60cm apart and in each row the plants are planted 45cm apart in such a way that no two plants are exactly opposite each other. The double rows are spaced at 1.5 to 2.0m. In this method 15,000-20,000 suckers can be accommodated per ha. When it is desired to have more than two ratoon crops, the above method can be adopted. Otherwise, close spacing may be chosen. In this method, early and higher yields are obtained from an unit area. In this method a spacing of 25 x 60 x 105 cm or 25 x 60 x 90 cm is adopted. This accommodates 49,000 to 53,000 suckers per hectare.

Preparation of Land

The selected site of land should be prepared very thoroughly by ploughing and cross ploughing or by forking or hand hoeing. If the land is undulating terracing should be practiced. The land should be dug upto a depth of 40-50cm till a fine tilth is obtained. At the last round of ploughing or digging FYM or compost is applied. After leveling, the land is laid out into trenches alternating with mounds for planting the suckers. For double row system of planting, two shallow furrows about 10-15 cm depth are to be opened.

Manures and Fertilizers

After plants have been established apply 16 g Nitrogen, 2g Phosphorus and 3g Potash per plant, two to three times. Application of 20-25 tonnes of FYM, 350kg Nitrogen, 130kg Phosphorusand 40kg Potash per hectare is recommended. FYM and P_2O_5 may be applied as basal dressing at the time of last ploughing or digging. Nitrogen and Potash are to be applied in three split doses i.e. 60th, 150th and 240th days after planting. Nitrogen may be supplied in the form of ammonium sulphate. Immediately after manuring, the crop should be irrigated and then earthedup to provide better anchorage to the plant.

Inter-cultivation

After planting, whenever weeds appear interculture should be done without digging of the soil deep. Mulching with dry grasses, straw, sawdust, coirdust, rice husk etc. will also help to suppress weed growth, conserve moisture, maintain the humus status of soil.

Irrigation

Though pineapple is a drought resistant crop, for getting high yields, it should be irrigated, atleast during the dry periods. Irrigations improve fruit size. Therefore, 4-6 irrigations in hot months at an interval of 15-20 days will ensure a good crop.

Flowering and Harvesting

To achieve uniform flowering in pineapple NAA in the form of Panofix at 10-20 ppm (1ml planofix in 9 lit of water) or a mixture of 10 ppm of Ethephon (ethrel) + 2% urea + 0.04% Sodium carbonate may be poured (50 ml) in the heart of the plants 15 to 16 month after planting on a clear sunny day. The Ethephon solution should be used immediately after preparation.

The plant generally flowers 12 months after planting from February of April. The fruits take about 135 to 165 days to mature and ripen. The fruits ripen from June to September depending on the variety. In our state fruits come to harvest from June to August.

To achieve good fruit size and uniform cylindrical shape the crowns of fruits may be removed with a sharp knife, when they are 5 to 10cm long. In hot weather the fruits may be covered by wrapping the fruits with the outer leaves or dry grass or straw or banana leaves or paper covers for protection from sun scorch.

When atleast 2 or 3 rows or eyes at the base have turned yellow, the fruit is ready for harvest. However, for distant markets less matured fruits are to be harvested. Harvesting may be done with a long, sharp knife, cutting the fruit stalk few centimeters below the base of the fruit. The fruit with the crown can be kept without damage of 3-4 days after harvest.

The yield per hectare varies from 40-60 tonnes depending on the variety.

Ratoon Crop

Ratoon cropping is common in pineapple. After the harvest of the first crop, all the suckers borne on the plant should be removed leaving only one sucker on the monter plant. Similarly all slips should be removed. Then the plants are fertilized, irrigated, and earthed up so that the plants have good anchorage for ratoon crop. The crop is retained like this for four or five years and then removed.

Uses

It is one of the most delicious of the tropical fruits. The furit is a good source of vitamins A and B. it is very rich in Vitamin 'C'. In addition, it constitutes an important raw material for the fruit processing and preservation industry. Pineapple is utilized in the fruit preservation and processing industries for preparation of canned pineapple in the form of slices, rings etc. The fruit juice is also canned, fruit is also used in the preparation of jam.

The dried waste after extraction of juice, known as pineapple bran, is used as a stock feed. Pineapple juice is utilized in the manufacture of alcohol, calcium citrate, citric acid, and vinegar.

PESTS

Mealy Bug (*Dysimicoccus brevipes*)

The bug causes wilt and eventual death of plants.

Control

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The pest can be controlled dipping the suckers in 10 ml Methyl parathion or 17ml of Dimethoaiate in 10 litres of water before planting by applying 1.7 kg ai/ha of Phorate granules and by treating the soil either with 2.75 kg/ha of Chlordane or 2.25 kg/ha of Heptachlor to kill the attendants.

DISEASES

Heart Rot (*Phytophthora parasitica*)

The disease is recognized by complete rotting of the central portion of the stem. The top leaves turn brown and basal portion of leaves shows sign of rotting with foul odour. It is more prevalent in high rainfall areas.

Control

Proper drainage is necessary to avoid this disease. Dip the planting material in 0.4% Difoltan at the time of planting. If the disease appears on plants, spray Difoltan @ 20g in 10 litres of water.

Soft Rot and Black Rot (*Ceratocystis paradoxa)*)

Most typical symptom is black rot of the butt in the field which is followed by wilting of foliage and breaking off of plants at ground level. Leaf spots are grey with dark margins later tuming olive-brown or white. Leaf tissues dry and leaves distorted. Water blisters are noticed as soft watery rot involving the flesh of fruit. Fruit sking becomes brittle and diseased portions disintegrate accompanied with a sweet smell. Infections occur through wounds and cut ends.

Control

Field sanitation, collection of suckers from disease free fields, exposing the planting material to sun for 2 hours, better drainage and periodical spraying with Bordeaux mixture from the time of flowering will control the diseases in the field. Dipping the cut end of the fruit stalk in a 10% solution of Benzoic acid in alcohol and spraying the packing shed and packing cases or baskets lith a 3% solution of Formalin will also help to check the diseases.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Molecular technique for detection and identification of virus

Article id: 22814

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INTRODUCTION

Plant pathogens infect a wide range of plant species and cause great yield and quality loss of agricultural crops. Detection and accurate identification of harmful plant pathogens is very essential to improve the strategies for controlling plant diseases. The early detection and identification of plant pathogens provides the basis for understanding their biology and appropriate strategies to control that particular pathogen. For the identification of plant pathogen, traditional procedures, i.e., isolation, in vitro culturing and microscopy of the extracellular pathogens, are in common routine.

Enzyme-linked immunosorbent assay (ELISA)

ELISA is useful for detecting large numbers of samples, and can provide quantitative as well as qualitative data in a short time. The technique was developed 25 years ago when Avrameas (1969) covalently linked an immunoglobulin (IgG) molecule to an enzyme, demonstrating that the enzyme-antibody conjugate retained the specificity of the IgG molecule as well as the catalytic properties of the enzyme.

Use of enzyme-linked antibodies for serological detection of plant pathogens, especially plant viruses, dramatically increased the sensitivity of pathogen detection methodologies. It is a plate-based assay technique and also used for detecting and quantifying substances such as peptides, proteins, antibodies, and hormones. Other names, such as enzyme immunoassay (EIA), are also used to describe the same technology.

Principle

As an analytic biochemistry assay, ELISA involves detection of an "analyte" (i.e. the specific substance whose presence is being quantitatively or qualitatively analyzed) in a liquid sample by a method that continues to use liquid reagents during the "analysis" (i.e. controlled sequence of biochemical reactions that will generate a signal which can be easily quantified and interpreted as a measure of the amount of analyte in the sample) that stays liquid and remains inside a reaction chamber or well needed to keep the reactants contained; It is opposed to "dry lab" that can use dry strips – and even if the sample is liquid (e.g. a measured small drop), the final detection step in "dry" analysis involves reading of a dried strip by methods such as reflectometry.

As a heterogenous assay, ELISA separates some component of the analytical reaction mixture by adsorbing certain components onto a solid phase which is physically immobilized. In ELISA, a liquid sample is added onto a stationary solid phase with special binding properties and is followed by multiple liquid reagents that are sequentially added, incubated and washed followed by some optical change (e.g. color development by the product of an enzymatic reaction) in the final liquid in the well from which the quantity of the analyte is measured.

The analyte is also called the ligand because it will specifically bind or ligate to a detection reagent, thus ELISA falls under the bigger category of ligand binding assays.

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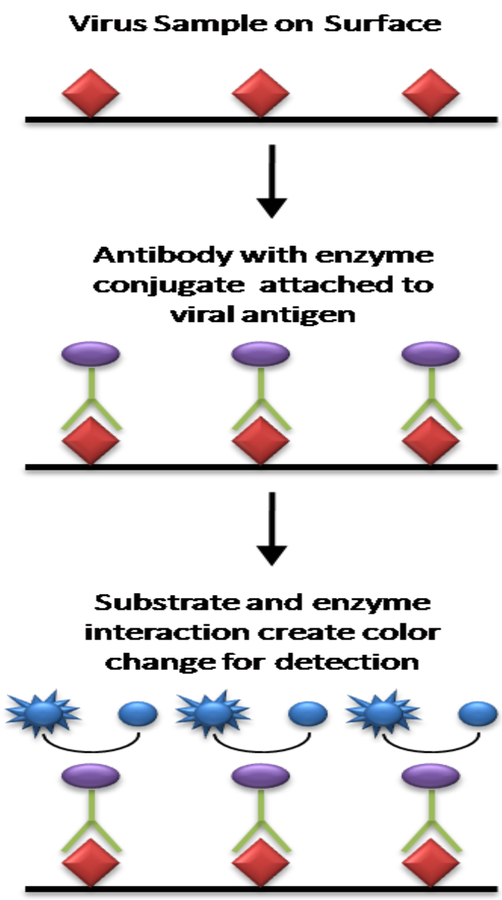
Types

DIRECT ELISA

The steps of direct ELISA follows the mechanism below:

1. A buffered solution of the antigen to be tested for is added to each well of a microtiter plate, where it is given time to adhere to the plastic through charge interactions.
2. A solution of nonreacting protein, such as bovine serum albumin or casein, is added to well (usually 96-well plates) in order to cover any plastic surface in the well which remains uncoated by the antigen.
3. The primary antibody with an attached (conjugated) enzyme is added, which binds specifically to the test antigen coating the well.
4. A substrate for this enzyme is then added. Often, this substrate changes color upon reaction with the enzyme.
5. The higher the concentration of the primary antibody present in the serum, the stronger the color change. Often, a spectrometer is used to give quantitative values for color strength.



Disadvantage of direct ELISA

A major disadvantage of the direct ELISA is the method of antigen immobilization is not specific; when serum is used as the source of test antigen, all proteins in the sample may stick to the microtiter plate

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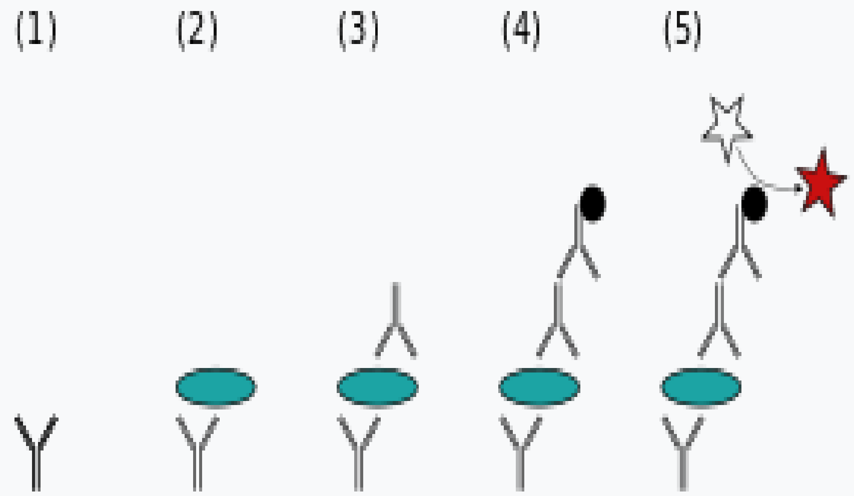
well, so small concentrations of analyte in serum must compete with other serum proteins when binding to the well surface.

The sandwich or indirect ELISA provides a solution to this problem, by using a "capture" antibody specific for the test antigen to pull it out of the serum's molecular mixture.

"Direct ELISA" refers to an ELISA in which only a labelled primary antibody is used, and the term "indirect ELISA" refers to an ELISA in which the antigen is bound by the primary antibody which then is detected by a labeled secondary antibody.

Sandwich ELISA



A sandwich ELISA.

(1) Plate is coated with a capture antibody;
(2) sample is added, and any antigen present binds to capture antibody;
(3) detecting antibody is added, and binds to antigen;
(4) enzyme-linked secondary antibody is added, and binds to detecting antibody;
(5) substrate is added, and is converted by enzyme to detectable form.

A "sandwich" ELISA is used to detect sample antigen. The steps are:

1. A surface is prepared to which a known quantity of capture antibody is bound.
2. Any nonspecific binding sites on the surface are blocked.
3. The antigen-containing sample is applied to the plate, and captured by antibody.
4. The plate is washed to remove unbound antigen.
5. A specific antibody is added, and binds to antigen (hence the 'sandwich': the antigen is stuck between two antibodies). This primary antibody could also be in the serum of a donor to be tested for reactivity towards the antigen.
6. Enzyme-linked secondary antibodies are applied as detection antibodies that also bind specifically to the antibody's Fc region (nonspecific).
7. The plate is washed to remove the unbound antibody-enzyme conjugates.
8. A chemical is added to be converted by the enzyme into a color or fluorescent or electrochemical signal.

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9. The absorbance or fluorescence or electrochemical signal (e.g., current) of the plate wells is measured to determine the presence and quantity of antigen.

Competitive ELISA

A third use of ELISA is through competitive binding. The steps for this ELISA are somewhat different from the first two examples:

1. Unlabeled antibody is incubated in the presence of its antigen (sample).
2. These bound antibody/antigen complexes are then added to an antigen-coated well.
3. The plate is washed, so unbound antibodies are removed. (The more antigen in the sample, the more Ag-Ab complexes are formed and so there are less unbound antibodies available to bind to the antigen in the well, hence "competition".)
4. The secondary antibody, specific to the primary antibody, is added. This second antibody is coupled to the enzyme.
5. A substrate is added, and remaining enzymes elicit a chromogenic or fluorescent signal.
6. The reaction is stopped to prevent eventual saturation of the signal.

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Effect of drought on stream insects and its ecological consequences

Article id: 22815

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INTRODUCTION

- Drought is defined as extended period (seasons to years) of deficit precipitation compared to the statistical long term average in a region.
- Types of Drought: 1) Meteorological drought 2) Hydrological drought and 3) Groundwater drought. Drought can also be classified as seasonal and supraseasonal drought.
- Stream insects play central ecological roles in virtually all running waters and are vital for flood plain and riparian food webs, processing organic matter and transporting energy along stream channels, vertically down into the stream bed and even laterally to the flood plains.
- In forest streams aquatic insects break down leaf litter, supplying nutrients, carbon and energy to the stream and associated ecosystems.
- Activities can alter water quality and influence energy flow patterns in different trophic levels
- Biological interactions often have significant effects on community structure.
- So, their diversity, distribution and assemblage are routinely assessed as an indicator of the 'health' of running waters (Boulton and Lake 2008).

Functional feeding groups

- Functional feeding groups varied across the gradient of the stream.
- Different functional feeding groups such as shredders (caddisfly and cranefly larvae), scrapers (caddisfly and mayfly larvae), collector-gatherers (stonefly larvae) and predators (water beetles) have important roles in stream nutrient cycling.
- In recent years, functional feeding groups have been used as bio-indicator and bio-monitoring organisms.
- Presence of pollution intolerant insect orders like Ephemeroptera (*Isonychia* sp., *Clypeocanis* sp., *Petersulla* sp. *and Isca* sp.), Trichoptera (*Helicopsyche*), indicate the good quality of river water,
- Whereas, pollution tolerant species like *Baetis* (mayfly) and *Hydropsyche* (caddisfly) that indicate poor quality of river water (Balachandran *et al*., 2012).

Impacts of Drought on Stream insects

- Sequential losses of hydrological connectivity
- Loss of lateral connectivity
- Loss of longitudinal connectivity
- Shrinking pools and "predator soup"
- Refuge use in dry stream bed

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Ecological Consequences of Progressive Loss of Stream Insects during Drought

- Organic matter processing and carbon transfer
- Food web dynamics
- Aquatic- terrestrial linkages
- Indirect effects of drought

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Vermi-wash: Role in Organic Agriculture for enhancing Crop Production

Article id: 22816

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INTRODUCTION

Vermiwash is an organic product of watery nature which is wash of earthworm's activity present in the medium. Vermiwash is a watery liquid of pale yellowish colour that is collected after the passage of water through a column of living earthworms in action. In other words it is a collection of excretory products and mucus secretion of earthworm along with micronutrients from the soil organic molecules from the medium. Today vermitechnology is successfully utilized for converting organic wastes into useful products through the action of living earthworms. The worm worked soils have burrows formed by the earthworms and bacteria richly inhabit these burrows termed as drillospheres. The water passing through these passages washes the nutrients from these burrows and is collected as vermiwash rich in nutrients which have a wide range of applications.

The vermiwash also contains enzymes and secretions of earthworms and would stimulate the growth and yield of crops. It contains various enzymes cocktail of protease, amylase, urease and phosphatise and also microbial study of vermiwash found that nitrogen fixing bacteria like Azotobacter sp., Agrobacterium sp., and Rhizobium sp., and some phosphate solubilising bacteria. It was reported that vermiwash as foliar spray was effective in increasing the growth and yield response of different crops.

How to Prepare Vermiwash from Vermicompost?

This process is mainly prepared to add nutrients to the soil. Compost is a natural fertilizer that allows an easy flow of water and to the growing the plants. The earthworms are mainly used in this process as they eat the organic matter and produce castings through their digestive systems.

The nutrients compositions of vermicompost are:

Nitrogen.	1.6 %
Phosphorus.	0.7 %
Potassium.	0.8 %
Calcium.	0.5 %
Magnesium.	0.2 %
Iron.	1.75 %
Manganese	96.5 %
Zinc.	24.5 %

Materials Required

- Water.
- Cow dung.
- Thatch Roof.
- Soil or Sand.
- Gunny bags.
- Earthworms.
- Weed biomass
- A large bin (plastic or cemented tank).
- Dry straw and leaves collected from paddy fields.
- Biodegradable wastes collected from fields and kitchen.
- Vermiwash collection tank or drum

Procedure

1. To prepare compost, either a plastic or a concrete tank can be used. The size of the tank depends upon the availability of raw materials.
2. Collect the biomass and place it under the sun for about 8-12 days. Now chop it to the required size using the cutter.
3. Prepare cow dung slurry and sprinkle it on the heap for quick decomposition.
4. Add a layer (2 – 3 inch) of soil or sand at the bottom of the tank.
5. Now prepare fine bedding by adding partially decomposed cow dung, dried leaves and other biodegradable wastes collected from fields and kitchen. Distribute them evenly on the sand layer.
6. Continue adding both the chopped bio-waste and partially decomposed cow dung layer-wise into the tank up to a depth of 0.5-1.0 ft.
7. Once, after adding all the bio-wastes, release the earthworm species over the mixture and cover the compost mixture with dry straw or gunny bags.
8. Sprinkle water on a regular basis to maintain the moisture content of the compost.
9. Cover the tank with a thatch roof to prevent the entry of ants, lizards, mouse, snakes, etc. and protect the compost from rainwater and direct sunshine.
10. Have a frequent check to avoid the compost from overheating. Maintain proper moisture and temperature and lastly collect the vermiwash into drum of various sizes.

- **Use of Vermiwash in different Crops.**

This can be used in any crop like kharif, ravi season as well as in the season of Vegetable crops. Vermiwash as growth promoter, Vermiwash alone or mix with cow urine is also an excellent growth promoter. Dilute one lit of vermiwash or 0.5 lit of vermiwash+ 0.5 lit of cow urine in 20 lit of water and use as foliar spray.

- **Advantages of Vermiwash**

The major benefits of vermiwash are:

1. Develops roots of the plants.
2. Improves the physical structure of the soil.
3. Vermicomposting increases the fertility and water-resistance of the soil.
4. Helps in germination, plant growth, and crop yield.
5. Nurtures soil with plant growth hormones such as auxins, gibberellic acid, etc.

Vermicomposting turns the kitchen waste and other green waste into dark, nutrient-rich soil. Due to the presence of microorganisms, it maintains a healthy soil.

Vermicomposting is an eco-friendly process that recycles organic waste into compost and produces valuable nutrients.

However it has some disadvantages

Enormously massive scale of vermiwash is not feasible with this product and if right quality of vermi- bed is not employed, then the entire material may go waste.

CONCLUSION

Vermiwash seems to possess an inherent property which acts not only as a liquid organic fertilizer but also as a mild biocide; it can be used as an effective input in organic agriculture for both soil health and disease management for sustainable crop production.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Mechanism of transgenic resistance crops

Article id: 22817

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In India, several herbicide-tolerant transgenic crops (referred to as HT GM crops) are in various stages of trials. In a context where HT GM crops occupy more than 83 % of the total GM planted in the world (Industry data, 2010) including 21% planted under stacked traits and at a time when there is a push to commercialise HT GM crops in India, it is important to understand the implications of this product for India's people and environment. A year after the introduction of the first commercial transgenic crop (Flavr Savr™ tomato with a longer shelf life) in 1994, transgenic, herbicide-resistant crops (HRCs) were introduced with the introduction of bromoxynil- (3,5-dibromo-4-hydroxybenzonitrile) resistant cotton and glufosinate- [2-amino-4- (hydroxymethylphosphinyl)butanoic acid] resistant canola. Bromoxynil resistance had little market penetration during the years when it was available. The next year, 1996, marked the introduction of the first glyphosate- [TV-(phosphonomethyl) glycine] resistant (GR) crop (soybean). Other GR and glufosinate-resistant crops were introduced in the subsequent years. GR crops now represent well over 80% of all transgenic crops grown worldwide (James 2008).

Table: Transgenic herbicide-resistant crops that have been deregulated (approved for sale) in North America

Herbicide Crop Year approved	Bromoxynil3 Cotton 1995	Canola 2000
Glufosinate Canola 1995	Maize 1997	Cotton 2004
Riceb 2006	Glyphosate Soybean 1996	Canola 1996
Cotton 1997	Maize 1998	Sugarbeet0 1999
Alfalfad 2005		
Herbicide Crop Year approved	Bromoxynil3 Cotton 1995	Canola 2000
Glufosinate Canola 1995	Maize 1997	Cotton 2004
Riceb 2006	Glyphosate Soybean 1996	Canola 1996

Transgenic herbicide resistant crops

• There has been growing interest over the past three decades in the development of crop varieties physiologically and biochemically resistant to nonselective herbicides or selective to only specific crops effective against a wide range of weed species.

Herbicide resistant biotech crops are meant to offer flexibility in management of weeds, reduce the number of applications in a season in long duration crops, enable using low toxicity compounds which do not remain active in the soil for long periods and facilitate using no-tilll conservation till systems.

• Generally there are two approaches in the transgenic engineering for herbicide resistance

A) Modification of plant enzyme or other sensitive biochemical target of herbicide action to render it insensitive to the herbicide, or inducing over production of the unmodified target protein permitting normal metabolism to occur.

B) Introduction of an enzyme or enzyme system that detoxifies the herbicide in the plant before it reaches the site of action.

Plants modified by both approaches may be obtained either by selection for resistance against a specific herbicide or by applying gene transfer technique utilizing genes encoding herbicide resistance determinants.

- The initial efforts to develop transgenic HRCs using genetic engineering techniques resulted in the release of bromoxynil resistant cotton in 1995 and canola in 2000
- Bromoxynil is not a broad-spectrum herbicide, therefore, bromoxynil resistance cotton and canola were discontinued.
- The real turning point occurred in 1996-97 with the commercial release of glyphosate resistant (GR) canola, soybean and cotton.

HRCs can be classified as

- non-transgenic (traditional genetic methods of selection of resistance traits) and
- transgenic (genetically engineered)

• Non-transgenic HRCs were developed using conventional breeding techniques. The first such example is triazine resistant canola that was developed through a breeding programme in 1984.

• Developments in plant genetic engineering and knowledge of biochemical action of herbicides on plants spurred innovative approaches to engineer crops to withstand herbicides.

Present HRCS and Their Impact

1. Commercially Available HRCs

- In 2008, after 14 years of HRCs, there are only nine different HRCs being grown in the US and only a few of these are grown in other countries. The adoption rate of GR soybean was rapid in the US, currently representing more than 90% of the area planted in soybean.
- Both cotton and maize have varieties that are either stand-alone GR varieties or varieties that combine GR and transgenic *Bt (.Bacillus thuriengensis* toxin) traits for insect resistance. GR cotton adoption was initially similar to that of soybean, but it has stabilized at about 70% , partly because of the adoption of glufosinate resistant cotton in places where it fits the weed problems better than GR cotton.

2. Herbicide Resistance in HRCs

- Plants can be made resistant to herbicides or other phytotoxins by a number of mechanisms.
- The molecular target site of the herbicide can be modified so that it no longer binds it and is thereby resistant.
- The plant can be altered to have a mechanism that prevents the herbicide from reaching the molecular target site (increased sequestration, or decreased uptake or translocation). These two approaches have been useful in producing commercial HRCs.

3. Impacts on Weed Management

Nothing has more impact on weed management in such a short time period as GR crops, except perhaps the introduction of synthetic, selective herbicides.

- A strong argument can be made that glyphosate is the most effective and useful herbicide available. It is a slow-acting, highly translocated, foliarly applied product that kills weeds by inhibiting a molecular target site that is ubiquitous to all plants, EPSPS (Duke et al. 2003a).

4. Herbicide-Resistant Crops and Crop Disease

- There are some untended benefits of GR crops and perhaps glufosinate-resistant crops. Both glyphosate and glufosinate are fungitoxic. Thus, when used at full application rates, these herbicides may, under some circumstances, be providing sufficient protection from plant pathogens to prevent crop damage or to preclude spraying with a fungicide.

- The most carefully studied example is that of glyphosate effects of Asian rust in GR soybeans (Feng et al. 2005, 2008), in which glyphosate applications to GR soybeans reduced rustinfection and damage, both as a preventative and a curative treatment.

Coming Herbicide-Resistant Crops

Glyphosate-Resistant Crops

A gene from the soil bacterium *Bacillus licheniformis,* which encoded a weak glyphosate /V-acetyltransferase (GAT) was put through 11 iterations of gene shuffling to increase its activity by almost four orders of magnitude. Properties of the resultant GAT are described by Siehl et al. (2005, 2007). Plants made resistant to glyphosate with this transgene were3 Transgenic Crops for Herbicide Resistance 155 ca. 100-fold more resistant to glyphosate than to nontransgenic lines (Green et al. 2008). Other glyphosate-inactivating enzymes are apparently encoded by genes of soil microbes, because there are other routes of degradation or inactivation. For example, a C-P lyase that converts glyphosate to inorganic phosphate and sarcosine is found in several bacteria, including *Arthrobacter* spp., *Rhizobium* spp., and *Pseudomonas* spp. (Kishore and Jacob 1987; Liu et al. 1991; Dick and Quinn 1995).

Potential impacts (risks and benefits) of HRCs and the herbicides that are used with them

• Risks and benefits are very geography and time dependent.

• The only herbicides currently being used with HRCs, glyphosate and glufosinate, are more environmentally and toxicological benign than many of the herbicides that they replace.

• The effects on soil, air and water contamination and on nontarget organisms are relatively small.

• Being broad spectrum, foliage applied herbicides, with little or no activity in soil, glyphosate or glufosinate are highly compatible with reduced or no tillage agriculture.

Future herbicide resistant crop technologies

• HRCs and other transgenic crops are here to stay

• The most important issue requiring attention following commercialization of HRCs has been the evolution of resistance to herbicides in weed populations.

• The agrochemical industry, seed companies and related entities have invested most of their resources in development of the next generation of HRCs (and other transgenic crops) with the aim of diversifying the growers crop portfolio as well as combating weed resistance by providing cropping technologies that allow application of more than one mode of action herbicides.

Worldwide use of transgenic crops

• Transgenic crops were first introduced in the 1990s.

• According to a 2010 database maintained by a non-profit environmental risk assessment institution, 60% (87 of 144) of all transgenic/biotechnological events reported involved herbicide resistance traits (CERA, 2010).

• All herbicide resistance traits that had regulatory approval did not result in commercialization and sales.

• In 2003, 67.7 million were planted to transgenic crops (both herbicide and insect resistance) in the world (Dill, 2005) and by 2010, the area increased to 148 million ha (James, 2010).

• The cumulative area planted to transgenic crops from 1996 to 2010 exceeded 1 billion ha.

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Global acreage and adoption of GMO versus non-GMO crops-latest statistics

• According to Industry funded group ISAAA (International Service for the Acquisition of Agri-Biotech Applications) – GM crops grew by 5.2 m ha to 175.2 m ha in 2013 [14], a modest 3 % increase. GM crops are still confined to 27 countries (one less than in 2012), 19 developing, 8 industrialized. Latin American, Asian and African farmers collectively grew 95 m ha (54 % total) compared with 81 m ha grown in industrialized countries (46 %). Herbicide tolerance (HT) crops - vast majority glyphosate tolerant – occupy 100 m ha, insect resistant 26 m ha and 45 m ha stacked HT and insect resistance.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Polyhouse farming

Article id: 22818
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INTRODUCTION:

Polyhouse, in general, is a tunnel like structure covered with using polyethylene. It is naturally ventilated and climate controlled. Generally polyhouse is of semicircular shape. Polyhouse farming is a new and widely accepted method of farming in present days. Mostly it is constructed in East to West direction to allow proper entry of sunlight. Polyhouses have a variety of applications, the majority being, growing of vegetables, floriculture, and planting material acclimatization, fruit crop growing for export market.

Greenhouse:

a) A greenhouse is a framed structure covered with a transparent material and large enough to grow crops under partial or full controlled environmental conditions to get optimum growth and productivity.
b) Of all agricultural production activities, the greenhouse industry is worldwide the fastest growing sector.
c) The use of the greenhouse is mainly for the production of seasonal and non-seasonal crops, for the production of high-quality flower, vegetable and the preparation of nursery prepared by tissue culture**.**

Difference between polyhouse and greenhouse:

- Polyhouse is one of the types of greenhouse in which polyethylene is used as the chief material for construction.
- The durability of the polyhouse is more compared to other types of Greenhouse.
- Polyhouse is more advanced in view of the technology.

How to start greenhouse/polyhouse farming?

To start greenhouse farming is required heavy expenditure on infrastructure, equipment, labour and raw materials. Farmers must have technical, economical and marketing knowledge. In India, there are various government organizations that provide greenhouse farming (polyhouse farming) training.

Steps:

Research → Application for bank loan → Application for greenhouse subsidy → An order to be placed to Greenhouse/Polyhouse → Construction Company → Plant ordering → Cultural practices →Marketing

Why polyhouse?

❖ One of the main reasons for the decrease in agriculture in India now-a-days is non availability of enough agricultural lands. So, the invention of polyhouse is a solution for lack of agricultural lands.
❖ Negative impacts of recent climatic changes on crop growth can be avoided by growing crops under controlled environment.

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Points to be considered before selecting greenhouse/polyhouse site:

Before deciding to start greenhouse farming, the following points should have to be considered for successful greenhouse/polyhouse farming (Castilla and Hernandez, 2007). Those are:

1. Soil pH should be between 5.5 and 6.5.
2. Continuous supply of water of good quality is to be assured.
3. The selected place should be clean and free from pollution.
4. There should be good transportation facility for shipping of goods in the market.
5. There should be excellent communication facilities in that place.
6. Availability of excellent drainage facility.

Types of polyhouse:

1. Classification based on system employed in environment manipulation

Environmental control in polyhouse farming: Crops are grown round the year by providing controlled environmental factors such as humidity, temperature, fertilizer, carbon dioxide and rooting medium. The following categories are maintained under this-

a) **Semi automatic control system:** Manual adjustments are needed to maintain the polyhouse in good condition. Proper alertness and technical skills should be needed while managing semi automatic polyhouse. Any deviation from this may result in damage of crop and may lead to loss.
b) **Fully automatic control system:** Pre-settings are enough for the maintenance of polyhouse. In an automatic system of polyhouse less attention is enough for maintenance, but it is very costlier compared to semi automatic type.

2. Classification based on establishment cost

(I) Low cost or low-tech polyhouse system:

- It is a zero-energy chamber made of polythene sheet of 700 gauge.
- It can be supported on low cost raw materials like wood or bamboo with 'sutli' and nails.
- It entirely depends on natural ventilation of (1-2) hours during morning for control of relative humidity and solar energy for control of inside temperature.
- Easy maintenance is possible.
- Best suitable for cold climatic condition.
- In general, UV radiation film is used as cladding material.
- Cost to set this low-tech polyhouse system is around Rs. 400 to Rs. 500 per square meter of area.

(II) Medium-tech polyhouse system:

- Single layer covering UV- stablilized polythene of 800 gauge on galvanized iron (G.I.) pipe (15 mm bore) is used for construction of this type of polyhouse system.
- Control of temperature and humidity is done by arranging cooling pads, mist controllers with thermostats and exhaust fan.
- It costs Rs. 900 to Rs. 1200 per square meter area to be set.

(III) Hi-tech polyhouse system:

- The most advanced polyhouse system.
- This type of polyhouse consists of a sensor, a comparator and an operator.
- All the environmental factors are controlled automatically for year-round crop growth.
- Very costly to set as it takes Rs. 2500 to Rs. 4000 for each square meter of area.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Importance and advantages of polyhouse farming: (Chakraborty and Sethi, 2015)

- It prevents the entry of animals and birds into the farm.
- There is a facility in polyhouse to control temperature or humidity.
- Water requirement of crops is very limited and easy to control.
- Efficient utilization of chemicals, pesticides to control pest and diseases.
- Fertilizer application on crops is easier as compared to field-grown crops.
- Better water use efficiency of crops due to availability of drip or sprinkler irrigation
- There will be an increase in the production of vegetables, fruits or flowers in polyhouse farming without losing their color and quality. In normal farming, farmers may face a loss of nearly 1/3rd of the crops due to various biotic and abiotic factors, whereas in polyhouse farming, we can expect about 3 to 5 times more of the crop yield.
- Disease-free and superior quality of produces obtained compared to open field situation where crops face several biotic and abiotic stresses.
- We can be independent of the season; year round production of crops (mainly vegetable and floricultural crops) can be achieved throughout the year.
- Handling of harvested products and their transporting is easier.

Best suited crops to be grown in polyhouse farming:

❖ Among vegetable crops; tomato, okra, eggplants, cabbage, broccoli, lettuce, carrot, summer squash, cucumber etc. have been reported to give better yield.
❖ Among fruit crops; watermelon, peach, strawberry, citrus fruit etc. are more popular.
❖ Growing spice crops like ginger, coriander, pepper, tuemeric etc. is possible.

Cost to set a polyhouse:

To set a polyhouse it costs around Rs. 750 to Rs. 1000 per square meter, depending on some factors like the material used, place selected, size, shape and structure of it. Based on these, two types are polyhouse costs are categorized.

Φ **Fixed cost:** land, office room, labor room, cold storage room, irrigation system etc. come under this category.
Φ **Variable/recurring cost:** this cost includes planting materials, chemicals, manures, fertilizers, electric bill and transportation charges.

Though it is costly to set and maintain a polyhouse, we can get the profit in large scale if we use it in a proper way. Government is encouraging polyhouse farming by giving 25% to 50% of subsidy to set up a polyhouse.

List of a reputed polyhouse construction company:

1. Shrihari Polyhouse (website- www.shriharipolyhouse.com)
2. Waman Enterprises (website- www.shriharipolyhouse.com)

Constraints in polyhouse farming:

❖ Basic cost of polyhouse construction is high.
❖ Uninterrupted power supply should be there for cooling and heating system.
❖ Cladding material of required quality is not always easily available.
❖ Lack of trained labour and necessary inputs like supply of water, proper seeds, fertilizers etc.
❖ Lack of improved breeding programme for development of new suitable varieties for cultivation under polyhouse (Ummyiah *et al.,* 2017).

Future Strategies:

- Standardizing proper design of construction of polyhouses.
- Developing cost effective agro-techniques.
- Awareness among farmers pertaining to the potential of polyhouse farming.

CONCLUSION:

Polyhouse farming is a modern method of farming in which we can expect more yields without compromising nutritive values of crop by limited use of harmful insecticides and other chemicals. We can also expect large scale of profit in short span of time from polyhouse farming.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Bio-priming: towards better plant health, productivity and climate change mitigation.

Article id: 22819
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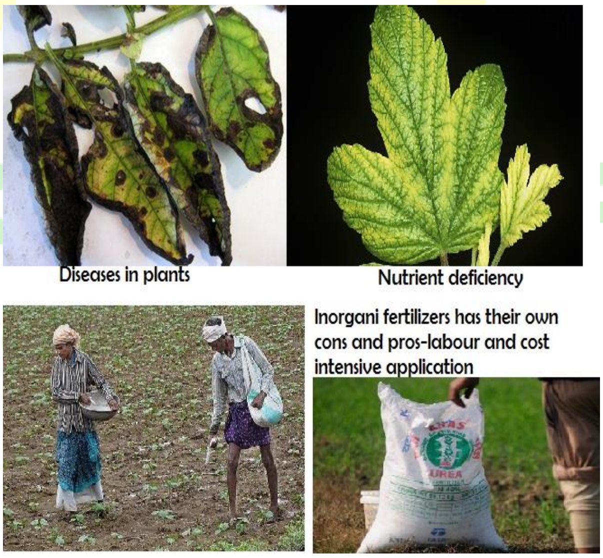
What is Bio-priming? Inoculation of seed with a beneficial microbial agent for various purposes is termed as bio-priming. It can also be called as 'Biological Seed Treatment'. Different beneficial bio-agents are used including various strains of bacteria, fungi along with their consortium. It is an advanced technology of treating seeds that includes biological (inoculation of seed with beneficial organism to protect seed) and physiological aspects (seed hydration) as an alternative method to control many seed- and soil-borne pathogens.it is definitely a a safe, non-polluting, and environmentally sound disease control measure and an effective pre-sowing seed treatment as it is using naturally occurring soil microorganisms. It helps a rapid colonization of the beneficial organism on the seed, and often results in a more uniform coverage of the seed surface as compared to other seed treatment techniques. It is a common practice in the seed industry worldwide. During the seed coating process, inoculants, fungicides, or insecticides are added together with other substances, which provide a protective barrier on the seed.

Different bio-priming agents:

Bacterial agents: *Bacillus subtilis, Pseudomonas fluorescens,* PGPR*, Azospirillum amazonense, Azospirillum brasilense, Rhizobium leguminosarum*

Fungal agents: *Trichoderma. Harzianum, Trichoderma longibrachiatum, Trichoderma. Asperellum, Glomus intraradices, Trichoderma virens, Meria coniospora*

Objectives of bio-priming: Stepping towards sustainable agriculture, Disease management, Reducing the dependence on inorganic fertilizers, Nutrient management, Stress management, Reducing the inorganic inputs



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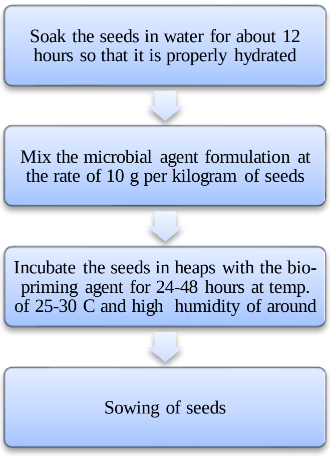
Different forms of bio-priming agents: Powder formulations, Spray: EC (emulsifiable concentrate), Granules: enriched in clays, Pellets: in Sodium alginate, Polymers: encapsulated in Sodium alginate.

How to do biopriming?



Biopriming of substrate:

Biopriming of soil: Mix 1kg of Bio-priming formulation in 100 kg of farmyard manure and cover it for 7 days with polythene. Sprinkle the heap with water intermittently. Turn the mixture in every 3-4 days interval and then broadcast in the field.

Biopriming of nursery bed: Apply 10 - 25 g of Biopriming formulation powder per 100 m2 of nursery bed. Application of neem cake and FYM before treatment increases the efficacy of the biopriming agent.

Suitability: Plants and Vegetables such as cauliflower, cotton, tobacco, soybean, sugarcane, sugarbeet, eggplant, red gram, Bengal gram, banana, tomato, chillies, potato, citrus, onion, groundnut, peas, sunflower, coffee, tea, ginger, turmeric, pepper, betel vine, cardamom etc.

Trichoderma is compatible with Organic manure and with biofertilizers like Rhizobium, Azospirillum, Bacillus Subtilis and Phosphobacteria.

Bio-priming in climate change mitigation: In Bio-priming,during seed imbibition temperature and moisture conditions of seeds are optimised. Microbial protectants used in the bio-treatment becomes established on the seeds. Seed priming increases the performance of seeds by improving its germination along with rapid seedling emergence. Bio-priming is a tool which enables the plants with better defence responses to combat biotic and abiotic stresses. During imbibition seeds undergo a number of repair mechanisms like repairing membranes of cells and organelles, as well as protein and enzyme activation to breakdown the food reserve. As higher production and productivity of crops is possible only through use of good quality seeds and their proper management practices.

e-ISSN: 2581 - 8317
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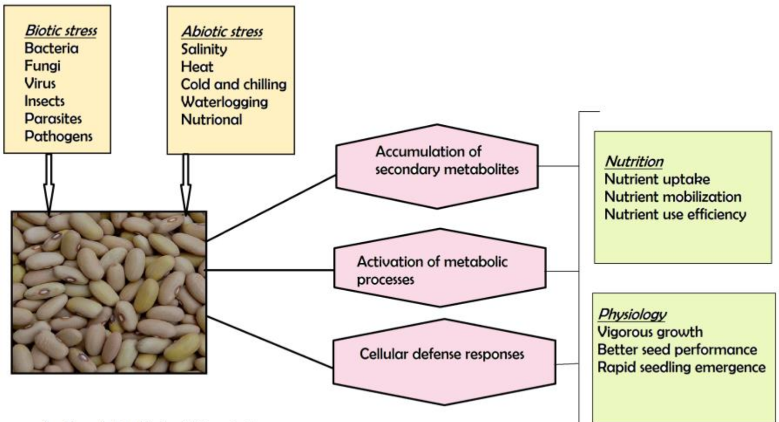

fig. Beneficial effects of Bio-priming

Biotic stress: Bacteria, Fungi, Virus, Insects, Parasites, Pathogens

Abiotic stress: Salinity, Heat, Cold and chilling, Waterlogging, Nutritional

Accumulation of secondary metabolites

Activation of metabolic process

Cellular defense responses

Nutrition: Nutrient uptake, Nutrient mobilization, Nutrient use efficiency

Physiology: Vigorous growth, Better seed performance, Rapid seedling emergence

Beneficial effects of biopriming

Bio-priming - The possibility: Increases the nutrient use efficiency, As a tool in integrated disease management system, Helps to fight different abiotic and biotic stresses. Reduces the cost incurred per unit of production. Pertaining to sustainability. Biological source

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Pros and Cons:

Advantages: Ecologically safe, Economically viable, Long term effect, Other accessory functions on plant growth, One of the best alternative to chemical method, Provides protection to seed forming coat of antagonists, Safe for environment and human health.

Disadvantages: High specificity, Slow action, Affected by biotic and abiotic factors, Optimality

Points to be kept in min: Microbial spores as 'foreign proteins' if inhaled or rubbed to skin may cause allergies. Accidental mixing of treated seeds with food and feed grains should not be happened. Environmental contamination by improper handling of treated seeds or seed treatment chemicals. Accidental exposure of workers who produce or carry out the seed treatment procedures. But all these risks can be minimized by proper training and proper use of bio-priming agents

CONCLUSION: Primed plants have increased resistance to several biotic or abiotic stresses. Biotization leads to improved plant nutrition. It induces biochemical changes in seeds and microbial changes in the rhizosphere. Safe for environment as well as human health. One of the best alternative to chemical agricultural inputs. Safer, cheaper and easily applicable.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Artificial intelligence in agriculture: strengthening the future of farming

Article id: 22820

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INTRODUCTION:

Agriculture or farming is one of the most primitive and significant professions worldwide but when we consider agriculture, we generally tend to think about old school farming. Although many of us might think that the agricultural community is lagging behind the curve when it comes to implementing new technologies. There are lots of evidences that farmers are actually trying to move quite quickly to modernize almost everything about the farming process. As the world population continues to grow and lands are becoming scarcer day by day due to rapid industrialization and urbanization, people must need to be creative and become more efficient about farming, using less land to produce more crops and increasing the productivity and yield of those farmed acres. Being one of the oldest sectors and the backbone of the country, developing the Agriculture industry has been a huge concern for the Indian government. A lot of factors such as climate change, population growth, and food security concerns, have propelled the sector to seek more innovative approaches to protect and improve crop yield as well as get better farming results. However, in this sector, several food producers today are struggling to manage threats to their crops against various biotic and abiotic stresses, which are made severe by climate change, monocropping, and prevalent pesticide use etc. Being a game-changer in other industries, the Indian government has realised the importance of Artificial intelligence (AI) and started to leverage this technology in developing the sector. As a result, AI is steadily emerging as part of the industry's technological evolution. Artificial intelligence holds the promise of driving an agricultural revolution at a time when the world must produce more food using fewer resources. Worldwide, agriculture is a US$5 trillion industry and foundation of the economy, and now the industry is turning to AI powered technologies in new and amazing ways to get healthier crops, control pests, monitor soil and growing conditions, organize data for farmers, help with workload, and improve a wide range of agriculture related tasks in the entire food supply chain. In this article, the AI-powered technologies in agricultural sector with an understanding of current and emerging trends, and present representative examples of popular applications will be explored.

The role of implementing artificial intelligence in agriculture sector:

Artificial intelligence is supporting agricultural sector to boost productivity and assisting to overcome the traditional challenges in every field. Modern technologies do not develop in isolation from one another; rather they co-evolve or emerge together in an evolving or emergent technological innovation system (Hekkert *et al*., 2007; Lee, Olsen & Trimi, 2012). Progressively more elements of the farm system will become automated as sensor technology, science models, AI, decision support software, and robotics become part of the farm management system (Sukkarieh, 2016). Likewise, adaption of AI technology is helping farmers to improve their efficiency, reduce environmental hostile impacts and control and manage any uninvited natural condition. The agriculture industry strongly and openly embraced AI into their practice to change the overall outcome. AI is shifting the way our food is produced where the agricultural sector's emissions have decreased by 20%. The use of Artificial intelligence helps the farmers to understand the data insights such as temperature, precipitation, wind speed, solar radiation *etc*. The best part of implementing AI is that it won't eliminate the jobs of human farmers rather it will improve their processes.

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- AI provides more efficient ways to produce, harvest and sell essential crops. Farmers are also using AI to create seasonal forecasting models to improve agricultural accuracy and increase productivity. These models are able to predict upcoming weather patterns ahead to assist decisions of farmers.
- AI implementation gives emphasis on checking defective crops and improving the potential for healthy crop production. AI systems are also helping to improve harvest quality and accuracy in precision agriculture; aid in detecting diseases, pests, and poor plant nutrition of plants; detect and target weeds and then decide which herbicides to apply within the right buffer zone. This helps to prevent over application of herbicides and excessive toxins that find their way in our food.
- The growth in Artificial Intelligence technology has strengthened agro-based businesses to run more efficiently.
- AI is being used in automated machine adjustments for analyzing a variety of things in real time such as weather conditions, temperature, water usage or soil conditions collected from their farm to better inform their decisions. AI sensors help farmers to optimize planning to generate more bountiful yields by determining crop choices, the best hybrid seed choices and resource utilization.
- In addition to ground data, farmers are also taking to the sky to monitor the farm. Computer vision and deep learning algorithms process data which are captured from drones flying over their fields. From drones, AI enabled cameras can capture images of the entire farm and analyze the images in near real time to identify problem areas and potential improvements. Unmanned drones are able to cover far more land in much less time than humans on foot allowing for large farms to be monitored more frequently.
- As many people are losing interest to take up farming as their profession, most farms are facing the challenge of a workforce shortage. However, as we have moved away from an agrarian society with large quantities of people living in farms to now large quantities of people living in cities, less people are able and willing to cultivate land. One solution to the shortage of workers is AI agriculture robots. These robots can augment the human labour workforce, harvest crops at a higher volume and faster pace than human labourers, more accurately identify and eliminate weeds, and reduce costs for farms by having a round the clock labour force.
- Utilizing AI with the image recognition approach is an efficient way to identify or monitor possible defects through images captured by the camera and nutrient deficiencies in the soil. With the help of AI enabled technologies, deep learning applications are being also developed to analyze flora patterns in agriculture.

Applications of AI in Agriculture:

1. Agricultural robots

Agricultural Robots are designed to handle and assist essential agricultural tasks such as harvesting, picking & packing crops more efficiently than human labourers, while combating other challenges within the agricultural labour force. They can protect the crops from harmful herbicide resistant weeds and automation and robotics can help farmers to find more efficient ways to protect their crops from weeds also. Automation can address challenges in the labour force. The industry is projected to experience a 6% decline in agricultural workers from 2014 to 2024. Robot mounted with a camera and a laser scanner can predict the expected yield of the plants. The robot can harvest 8 acres in a single day and replace 30 human labourers.

2. Plantix app

Plantix app uses images to detect plant diseases, diagnose pest damages, and identify potential defects and nutrient deficiencies in soil. The farmers can participate in the online community with other farmers to discuss about plant health issues and access their local weather reports. Users are provided with soil

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

restoration techniques and analysis is conducted by software algorithms which correlate particular foliage patterns with certain soil defects, plant pests & diseases.

3. Drones

Drone technology helps users to improve their crop yield & reduce costs. Users pre-program the drone's route and once deployed the device will leverage computer vision to record images which will be used for analysis. When the drone completes its route, users can transfer a USB drive from the drone to the computer and upload the captured data to a cloud drive and then it can use algorithms to integrate & analyze the captured images and data. This imaging technology can assist in the identification of crops and their progress, including their health, and the determination of their readiness, as well as these images can provide farmers with the ability to determine how ripe their crops are, and if and when they will be ready for harvest. It can assist the overall field management, providing estimates in real-time identifying where specific crops may require more water, fertilizer, soil or pesticides *etc*. Agricultural drones allow farmers to see their fields from the sky. This birds-eye view would expose intending issues on the farm such as irrigation problems, soil variation as well as pest and fungal infestations. Having identified these issues, the farmer can come up with solutions to improve crop management and production. In agriculture, there are major applications of drone technology, such as crop monitoring, crop volume and vigour assessments, crop inventory, generation of prescription maps, precision spraying, an inspection of farm infrastructure, high-resolution mapping and surveying of individual fields, crop damage assessment & insurance claim forensics. Drones can detect these subtle changes in the crops before they are discernible to the human eye, thus enabling early intervention and saving farmers from losses.

4. Driverless tractors

A driverless tractor is an autonomous farm vehicle that delivers a very high effort at slow speeds for the purpose of tillage and other agricultural tasks and it can operate without the presence of a human inside the tractor itself. Self-driving tractors have the potential to optimize on-farm operations and offer a safer, less stressful working environment for farm workers and their families. They operate with the aid of a supervisor monitoring the progress at a control station or with remote control from a distance.

5. Precise Farming

Precision farming uses Artificial intelligence to generate accurate and controlled techniques that offer guidance & understanding about water and nutrient management, optimal harvesting and planting times as well as selecting appropriate cropping pattern. These processes make farming more efficient, and can help to predict benefit cost ratio of specific crops based on their costs and margin within the marke.

Disadvantages of AI in Agriculture: Though Artificial Intelligence offers vast opportunities for application in agriculture, there still exists a lack of familiarity with high tech machine learning solutions in farms across most parts of the world.

- Although Artificial intelligence improves the agriculture industry in many amazing ways, there are many concerns regarding the forthcoming of AI on employment and the workforce of the agricultural sectors. There are millions of unemployed field workers in the next decades primarily due to the impact of AI in the agriculture industry.
- AI systems also need a lot of data to train machines and to make precise predictions. In case of vast agricultural land, though spatial data can be gathered easily, temporal data is hard to get. For example, most of the crop specific data can be obtained only once in a year when the crops are growing. Since the data infrastructure takes time to mature, it requires a significant amount of time to build a robust machine learning model.

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- Field tasks which are monotonous can be easily automated and this can gradually make certain roles obsolete. Humans will be replaced by smart robots that can safely navigate the space, find and move agricultural products as well as perform simple and complex field operations.
- The cost of technology such as drones has made it unavailable outside of the government and research bodies. It is costly to buy the drones, the biggest challenge will be funding internally from the government efforts and research institutions.

Government of India with IBM

The government of India has decided to use AI-based sensors and satellite technology to monitor the agriculture sector of the country to secure the farming capabilities of Indian farmers. It will provide weather forecast and soil moisture information to farmers to take pre-informed decisions regarding better management of water, soil and crop. This initiative was aimed at improving the future of farming by harnessing multiple data points and combine predictive analytics, AI, satellite data, and sensors to give farmers insights on ploughing, choosing crops, spraying pesticides, and harvesting

1. Pradhan Mantri Fasal Bima Yojana (PMFBY)

This is a government sponsored crop insurance scheme that integrates multiple stakeholders on a single platform. To improve the crop sector, the government will now envisage the use of innovative technologies like AI, remote sensing imageries, and modelling tools to reduce the time lag for settling of claims of the farmers. By analysing the data collected, the scheme aims at increasing the crop insurance penetration in India by increasing farmer awareness and reducing farmer premium rates. PMFBY will be providing financial support to farmers who are suffering from crop loss or damage arising out of unforeseen events, along with stabilizing the income of farmers to ensure their continuance in farming. The scheme will also encourage farmers to adopt innovative technologies and modern agricultural practices. It also ensures the flow of credit to the agriculture sector, which will contribute to food security, crop diversification and enhancing growth and competitiveness of the agriculture sector besides protecting farmers from production risks.

2. PM-KISAN

By leveraging the benefits of AI, the government of India has rolled out a scheme, PM-KISAN, where every farmer is going to receive Rs. 6000 annually to support their farming abilities. The government is aimed to leverage the huge amount of collected data by several agri-schemes and use the same to better target the farmer who requires the benefit of it. The data will be used in creating a proper framework for farmers, along with the right policy. It will also help in converging some government projects to achieve the targeted development of farmers and the overall sector.

3. AGRI-UDAAN

In a bid to push innovative technologies in agriculture sector, the government of India has also launched another initiative, AGRI-UDAAN in cities like Chandigarh, Ahmedabad, Pune, Bengaluru, Kolkata and Hyderabad, and enable them to connect with potential investors. This initiative is a six month programme in which shortlisted Agri start ups with innovative business models will be mentored and guided to improve their operations, enhance commercialisation, improve product validation and business plan preparation, risk analysis, customer engagement, finance management, and fundraising.

4. Maha Agri Tech Project

This Maharashtra project seeks to use innovative technologies to address various risks related to cultivation such as poor rains, pest attacks, *etc*. and to accurately predict crop yield. The project will also use this data to inform farmers about several policy requirements including pricing, warehousing and crop insurance. The first phase of the project uses satellite images and the data analysis is done by Maharashtra Remote Sensing Application Centre (MRSAC) and the National Remote Sensing Centre

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(NRSC) to assess the area of land, and the conditions of selected crops in selected talukas. However, the second phase includes an analysis of the collected data to build a seamless framework for agriculture modelling and a geospatial database of soil nutrients, rainfall, and moisture stress to facilitate location specific advisories to farmers.

CONCLUSION: The dire demand for food is the most fundamental for our survival and the need is never ending. Fortunately, the use of AI will allow farms of all sizes to operate and function for keeping our world fed. Through the use of Artificial intelligence and cognitive technologies, farms across the world are able to run more efficiently to produce the fundamental staples of our dietary lifestyles. AI-driven technologies are emerging to improve efficiency and to address challenges facing the industry including, crop yield, soil health and herbicide resistance *etc*. Agricultural robots are poised to become a highly valued application of AI in this sector. Crop and soil monitoring technologies will also be important applications going forward as climate change continue to be researched and evaluated. The amount of data that can potentially be captured by technologies such as drones, and satellites on a daily basis will give agricultural business a new ability to predict changes and identify opportunities. We anticipate that the agricultural industry will continue to see a steady adoption of AI and will continue to monitor this trend. AI can be appropriate and efficacious in agriculture sector as it optimizes the resource use and efficiency. It solves the scarcity of resources and labour to a large extent. Artificial intelligence can be technological revolution and boom in agriculture to feed the increasing human population of world and will complement and challenge to make right decision by farmers. The world of Artificial Intelligence (AI) is quickly on the rise as it makes its way into many different industries. From manufacturing to automotive, you can likely see AI used for many different purposes; and as time goes on, you'll only see it even more. One of the most interesting industries that AI is breaking into is agriculture, a major industry and a huge part of the foundation of our economy. According to the Environmental Protection Agency (EPA), the agricultural industry contributes nearly $330 billion annual revenue to our economy. As climates are changing and populations are increasing, AI is becoming a technological innovation that is improving and protecting crop yield in the world.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Enemies of Lac insect and their management

Article id: 22821

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INTRODUCTION:

India is the leading lac producing country in the world (2017-18: 14,217 tons). Lac insect or scale insect *Laccifer lacca* (*Laccifer lacca*: Homoptera) secretes a resinous byproduct which is marketed as shellac (Prasad, 2014). The main use of lac until 1960s was in the manufacture of gramophone records. Today, due to its strength and excellent bonding properties as well as its non-toxicity nature, it is using in making industrial products including varnishes and polishes, pharmaceuticals, ornaments, confectionary, adhesives, printing inks, leather and wood finishing, fruits and vegetables coating.

Lac strains:

1) Kusumi strain:

- Grown on kusum plants (*Schleichera oleon*)
- Aghani (Winter) and Jethwi (Summer), each six months duration.

2) Rangeeni strain:

- Grown on palas (*Butea monosperma*) and ber (*Ziziphus mauritiana*)
- Katki (Rainy season) and Baisakhi (Summer), four- and eight-months duration respectively.

3) Trivoltine:

- Insects found in coastal areas of Odisha and West Bengal
- Matures in March/April, June/July and oct.

Productivity of lac depends on availability of healthy shoots on host plants, damage done by host pests has direct bearing on it. Pests of hosts, particularly sucking insects, defoliators and termites cause damage to the host plants.

Pests of Lac insect:

1. Predators: 19 predators of lac insects recorded

Three predators are most important

a) Larger white lac moth, *Eublemma amabilis* (Noctuidae: Lepidoptera)
b) Smaller black lac moth, *Pseudohypatopa (Holocera) pulverea* (Blastobasidae: Lepidoptera)
c) Lace wing fly, *Chrysopa* sp.

2. Parasitoids: 26 parasitoids were recorded

Most important of them are

a) *Aprostocetus purpureus* b) *Tachardiaephagus tachardiae*
c) *Parechthrodryinus clavicornis* d) *Eupelmus tachardiae* e) *Erencyrtus dewitzi*

Pest management:

1. Preventive measures

- Parasite and predator free brood lac should be used for inoculation.
- Phunki (empty broodlac sticks) should be removed from the inoculated trees within 2-3 weeks time after the inoculation

- Scraping or fumigation of excess lac stick after inoculation and also after phunki removal at ones.
- Cultivation of *Kusumi* strain should be avoided in a predominantly rangeeni area and vice-versa.

2. Cultural control

- Early inoculation: Inoculation of lac crop earlier by 10-15 days than normal crop
- Trap crop: some of the host plants are inoculated with higher brood rate to attract the predators for egg laying. These plants serve as trap crops and have a greater incidence of predators that can be harvested as aril ac (immature lac)
- Inter cropping: Inter cropping of cotton and okra with lac can increase the population of natural parasites common to the crops.

3. Mechanical control:

- Sixty mesh synthetic net container bags may be used for inoculation of broodlac
- Emerging lac crawlers easily crawl out from the minute pores of the bag and settle on the twigs of the lac host plants, while the emerging adult enemy predator moths get entrapped within the net.
- Check the egg laying by the adult moths on the new crop and reduce pest infestation.

4. Microbial Control

- *E. amabilis* and *P. pulverea* can be controlled by the use of bio-pesticide *Bacillus thuringiensis* Berliner under field conditions.

5. Biological control

- Ant predators *viz*. *Componotus campressus* and *Solenopsis geminata rufa* are effective in controlling the lac predators by attacking the larvae and pupae of both *E. amabilis* and *P. pulverea.*
- Egg parasitoids - *Trichogramma pretiosum*, *T. chilonis*, *T. brasiliensis*, *Trichogrammatoidea bactrae* and *Telenomus remus* are effective in controlling the predators (David and Ramamurthy, 2017).

6. Chemical control

- Fipronil 5 EC/SC Regent® 0.007% 1.5ml per lit of water
- Fipronil 80 WG Jump® 0.007% 0.1g per lit of water
- Ethofenprox 10EC Nukil, Bombard® 0.02% 2ml per lit of water

Treatment of broodlac with insecticides

Dipping of broodlac in Indoxacarb (0.007%) or Fipronil (0.007%) for 10-15 minutes reduces the population of Lepidopteran predators.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Enhancing water productivity through crop management

Article id: 22822

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INTRODUCTION:

As water resources around the world are threatened by scarcity, degradation and overuse, and food demands are projected to increase, it is important to improve our ability to produce food with less water. There are only a few basic methods of using earth's water resources to meet the growing food demands: continuing to expand rainfed and irrigated lands; increasing production per unit of water; trade in food commodities; and changes in consumption practices. Land expansion is no longer a viable solution (Godfray *et al*., 2010). Therefore, improving agricultural productivity on existing lands using the same amount of water will be essential. India is the largest freshwater user in the world as well as country's total water use is greater than any other continent. Agricultural sector is the largest consumer and irrigation water for agriculture finds competition from domestic use, industrial and hydroelectric projects. As water demand from cities and industries is increasing rapidly, pressure is also mounting on agriculture to enhance water efficiency. In intensive agriculture, both fertilizer and irrigation management have contributed immensely in increasing the yield and quality of crops. Water is the most vital physical factor for agricultural production after land. Irrigated agriculture has been an important contributor to the expansion of national and world food supplies since 1960's and is expected to play a major role in feeding the burgeoning population. Water scarcity presents a big threat to future food production as many fresh water sources (surface & ground) are depleting faster. Traditional irrigation methods are no longer viable. The dominant method of irrigation practiced in large parts of the country is surface irrigation under which crop utilize only less than one half of the water released and remaining half gets lost in conveyance, application, runoff and evaporation. Although considerable area has been brought under irrigation since independence; there is much scope for its expansion in the future. At present, the efficiency of the irrigation systems adopted is less than 40%. As such as 50% of the water release at the project head is lost in transmission of the canal outlet. Scientific management of irrigation water is necessary to improve crop productivity and alleviate irrigation related problems such as shortage of irrigation water, water logging, salinity *etc*. Even all the water resources have been tapped for irrigation; almost 50% area will still remain rainfed. But, whether it is irrigated or rainfed agriculture water holds the key for enhancing and sustaining agricultural production. Since, sustainability and enhanced productivity are the need of the hour; the focus has to shift from crops to cropping systems that are more input use efficient going with resource conservation technologies. There is immense scope for conservation, distribution and on farm utilization of water and attaining higher water use efficiency through micro irrigation system; yield can be maximized significantly with a limited amount of water. Modern irrigation techniques like sprinkler and drip should be promoted where water is scarce and the topographic and soil condition do not permit conventional methods of irrigation. Increasing water productivity means using less water to complete a particular task, or using the same amount of water, but producing more and has been associated with improved food security and livelihoods (Cook *et al*., 2009b; Cai *et al*., 2011). Additionally, it leads to savings in fresh water, making it available for other uses, such as healthy ecosystem functioning. Improved water productivity is therefore an important element in improved management of water and ecosystems for sustainable agriculture and food security.

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With growing irrigation water demand and increasing competition across water using sectors, the world now faces a challenge to produce more food with less water. It is the high time to shift focus from land to water productivity in farming.
Irrigation is modernizing........

Traditional paradigm

- Fixed allocation
- Irrigated areas in hectares
- kg/ha
- "Use it or lose it"
- "Free" water
- Centralized management
- Quantity service

→

New paradigm

- Flexible allocation
- Level of efficiency
- Rs./ m^3
- Systems benefit
- "Metered" water
- User management
- Quality service

Water productivity

- Water productivity is the amount of beneficial output per unit of water depleted.
- In its broadest sense, it reflects the objectives of producing more food, and the associated income, livelihood and ecological benefits, at a lower social and environmental cost per unit of water used (Molden *et al*., 2007).
- Usually, water productivity is defined as a mass (kg), monetary ($) or energy (calorific) value of produce per unit of water evapotranspired (Kijne *et al*., 2003; Molden *et al*., 2010), and, as such, it is a measure of the ability of agricultural systems to convert water into food.
- Water productivity denotes the amount or value of product over volume or value of water depleted or diverted.
- Reported data on water productivity show considerable variation, *e.g*. wheat 0.6-1.9 kg/m^3, maize 1.2-2.3 kg/m^3, rice 0.5-1.1 kg/m^3, forage sorghum 7-8 kg/m^3 and potato tubers 6.2-11.6 kg/m^3.

Why it is important?

- To meet the rising demand for food for a growing and increasingly urbanized population in light of water scarcity.
- To respond to pressure of reallocating water from agriculture to cities and to ensure that water is available for environmental uses
- To contribute to poverty alleviation and economic growth

Key principles for improving water productivity

- Increase the marketable yield of crop for each unit of water transpired by it
- Reduce all outflows (*e.g.* drainage, seepage and percolation), including evaporative outflows other than the stomatal transpiration
- Increase the effective use of rainfall, stored water, and water of marginal quality.

All these options lead to the improvement of on-farm management aspects of crop growth, through the application of the best crop management practices which will permit to use less water for irrigation,

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

decrease evaporation losses, optimize fertilizer supply, allow better pest control, minimize energy consumption and improve soil conditions.

Opportunities for Increasing Water Productivity

• Capacity utilization of minor irrigation system
• Command Area Development
• Drought alleviation
• Increasing water use efficiency
• Alternate Wetting and Drying (AWD) Method for water saving
• Salinity management
• Arsenic in Water
• Institutional arrangement

Enhancing water productivity at plant level

- Germplasm improvements *e.g.* improving seedling vigour, increasing rooting depth, harvest index and enhancing photosynthetic efficiency.
- Improvements in breeding programmes to develop an appropriate growing cycle such that the duration of the vegetative and reproductive periods are well matched with the expected water supply or with the absence of crop hazards.
- Improved varieties with a deeper rooting system contribute to drought avoidance and the effective use of water stored in the soil profile.
- Day length insensitive varieties of short to medium duration (90-120 days) enabled crops such as wheat, rice and maize varieties, *e.g.* modern rice varieties have about a threefold increase in water productivity compared with traditional varieties.
- Genetic engineering, if properly integrated in breeding programmes and applied in a safe manner.

Raising water productivity at field level

- Selecting well adapted water efficient crops and cultivars
- Planting methods (*e.g.* raised beds), reduced tillage and minimum tillage
- Timely irrigation to synchronize water application with the most sensitive growing periods *i.e.* improved irrigation scheduling on account of rainfall variability
- Improved drainage for water table control
- All cultural and agronomic practices that reduce the losses of water such as different row spacing and the application of mulches
- Integrated crop and resource management practices such as improved nutrient management
- Integrated weed and integrated pest management
- Deficit irrigation, where deliberately less water is applied than that required to meet the full crop water demand
- Water saving irrigation techniques such as saturated soil culture and alternate wetting and drying
- System of rice intensification (SRI)
- Aerobic rice systems that allow rice cultivation in non flooded conditions
- Bridging crop water deficits during dry spells through supplementary irrigation if water is applied at the moisture sensitive stages of plant growth
- Water harvesting
- Runoff farming where the collected runoff is applied directly to the cultivated area

- Farmer's participation and empowerment through the organization of WUAs in irrigation management
- Better land-use planning
- Better use of medium term weather forecasts
- Conjunctive management of various sources of water, including water of poorer quality where appropriate.
- Integrating germplasm improvement and resource management at field scale and above.
- More reliable irrigation supplies, *e.g.* through precision technology and the introduction of on demand delivery of irrigation supplies
- The use of drought and disease resistant crop varieties
- Micro irrigation (MI) methods like drip and sprinklers need to be employed for efficient distribution and application of water
- Sustainability and enhanced productivity are the need of the hour; the focus has to shift from crops to cropping systems that are more input use efficient

Why modern irrigation technologies are needed?

• The productivity of irrigated land is low compared to its potential
• The productivity per unit water is very low
• Water available for irrigation is becoming scarce
• Cost for generating water source is ever increasing
• The predominance of soils with low water retention capacities and very low hydraulic conductivities make the arid and semi-arid regions an ideal case for light and frequent irrigations through micro-irrigation
• Micro-irrigation will increase the irrigation cover using the existing available water
• Micro-irrigation with fertigation will enhance production per unit input in these nutrient poor, shallow and sloppy soils

CONCLUSION

Growing physical shortage of water and scarcity of economically accessible water owing to increasing cost of production and supply of the resource had preoccupied researchers with increasing productivity of water use in agriculture in order to get maximum production or value from every unit of water used. Raising water productivity is the cornerstone of any demand management strategy. Water Productivity is a measure of the economic or biophysical gain from the use of a unit of water consumed in crop production. With rising competition of finite water resources, uncertainties linked to climate change and the steady rise in demand for agricultural commodities, increasing water productivity is essential to achieve water and food security. Given that Indian agriculture uses almost 80% of all the country's water resources, which are increasingly under stress, changing the objective of agriculture development to increasing productivity per unit of water, especially irrigation water is crucial. Therefore, enhancing water productivity is an important element in improved water management for sustainable agriculture, food security and healthy ecosystem functioning.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Food Preservation: A Bane or Boon

Article id: 22823

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Introduction

Food is the main aspect that man serves, receives and sweats his life, but what if it's not worth it. Therefore, there have been a variety of developments in food technology that have led not only in quality but also in its outward aesthetic appeal to raise the standard of food. Chemicals added to food are known as food additives for preservation or enhancement of their appealing flavor, etc. Food preservatives are the chemical substances added to prevent their spoilage and also retain the nutritional value of a specific food product for a comparatively longer period of time in certain cases. These chemicals prevent the rancidity of Feed and growth suppression or microbial destruction. Sodium benzoate is the most popular preservative in use. Many food preservatives used for edible oils such as BHA and BHT serve as antioxidants.

Positive side of Food Storage (Boon)

- It protects food for longer periods.
- Eliminate bacteria and other contamination causing agents.
- Improve the diet.
- It is helpful in transportation.
- Improve organoleptic properties of produce.

Role of processed food is unambiguous in maintaining food security and economic development; but it has a dark side to health concerns. The growing concerns associated with the use of processed food are due to some unnecessary ingredients used in the preservation process; chemical preservatives and high salt and sugar concentrations. Studies indicate side effects of eating processed foods that lead to obesity, diabetes, and cardiovascular problems.

Negative side of Food Preservation (Bane)

- Misuse of food processing Technologies.
- Use of Harmful additives.
- Micronutrient loss during food processing process.

CONCLUSION

For making a balance between being able to prepare and procure food and stay healthy depends on wise choices when shopping for food. Only reading the food packet label to learn about the ingredients in it goes a long way to let us know what's on our plate. It can also help to avoid' ultra-processed' products such as soft drinks and chips and substitute them with less-processed alternatives such as frozen fruits and vegetables or pasteurized milk. Particularly in India, people feel that eating food that contains quantities of preservatives and is deemed unhealthy is wrong, and this is not exactly true. For maximum cases, after completing several screening tests, these items are released onto the market and only after Food Corporation grant them the allowance to be sold on the market. Because we know anything in abundance leads to sudden issues and health problems, therefore food preservation works more as a blessing than a bane when it is used to proper proportions of additives.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Compatibility of different chemical fertilizers

Article id: 22824

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Fertilizer compatibility:

Some fertilizers can be mixed and some fertilizers cannot be mixed while spraying. Improper mixing and storage of fertilizers can result in nutrient losses. Some important aspects to consider in fertilizer mixing and storage include the following:

Muriate of Potash:

Muriate of Potash can be mixed with Sulphate of Potash, Ammonium sulphate, Single Super Phosphate and Triple Super Phosphate,Ammonium phosphate,Basic slag and Calcium Carbonate. Muriate of potash can be mixed with Calcium Ammonium Nitrate,Sodium nitrate,Calcium cynamide and Urea some time before using.

Sulphate of Potash:

Sulphate of Potash can be mixed with Muriate of Potash,Ammonium Sulphate,Calcium cynamide,Single Super Phosphate and Triple Super Phosphate,Ammonium phosphate,Basic slag and Calcium Carbonate. Sulphate of Potash can be mixed with Calcium Ammonium Nitrate,Sodium nitrate and Urea some time before using.

Ammonium Sulphate:

Ammonium Sulphate can be mixed with Muriate of Potash,Sulphate of Potash,Calcium Ammonium Nitrate,Sodium nitrate,Single Super Phosphate and Triple Super Phosphate and Ammonium phosphate. Ammonium Sulphate can be mixed with Urea some time before using. Ammonium Sulphate should not be mixed with Calcium cynamide,Basic slag and Calcium Carbonate.

Calcium Ammonium Nitrate:

Calcium Ammonium Nitrate can be mixed with Ammonium Sulphate,Sodium nitrate and Calcium Carbonate. Calcium Ammonium Nitrate can be mixed with Muriate of Potash,Sulphate of Potash,Urea,Single Super Phosphate and Triple Super Phosphate and Ammonium phosphate some time before using. Calcium Ammonium Nitrate should not be mixed with Calcium cynamide and Basic slag.

Sodium nitrate:

Sodium nitrate can be mixed with Basic slag and Calcium Carbonate. Sodium nitrate can be mixed with Muriate of Potash,Sulphate of Potash,Ammonium Sulphate,Calcium Ammonium Nitrate,Calcium cynamide,Urea,Single Super Phosphate and Triple Super Phosphate and Ammonium phosphate some time before using.

Calcium cynamide:

Calcium cynamide can be mixed with Sulphate of Potash,Urea,Basic slag and Calcium Carbonate. Calcium cynamide can be mixed with Muriate of Potash and Sodium nitrate some time before using. Calcium cynamide should not be mixed with Ammonium Sulphate,Calcium Ammonium Nitrate,Single Super Phosphate and Triple Super Phosphate and Ammonium phosphate.

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Urea:

Urea can be mixed with Calcium cynamide. Urea can be mixed with Muriate of Potash,Sulphate of Potash,Ammonium Sulphate,Calcium Ammonium Nitrate,Sodium nitrate,Basic slag and Calcium Carbonate some time before using.

Single Super Phosphate and Triple Super Phosphate:

Single Super Phosphate and Triple Super Phosphate can be mixed with Muriate of Potash,Sulphate of Potash,Ammonium Sulphate,Single Super Phosphate and Triple Super Phosphate and Ammonium phosphate. Single Super Phosphate and Triple Super Phosphate can be mixed with Calcium Ammonium Nitrate,Sodium nitrate and Urea some time before using. Single Super Phosphate and Triple Super Phosphate should not be mixed with Calcium cynamide,Basic slag and Calcium Carbonate.

Ammonium phosphate:

Ammonium phosphate can be mixed with Muriate of Potash,Sulphate of Potash,Ammonium Sulphate and Single Super Phosphate and Triple Super Phosphate. Ammonium phosphate can be mixed with Calcium Ammonium Nitrate,Sodium nitrate and Urea some time before using. Ammonium phosphate should not be mixed with Calcium cynamide,Basic slag and Calcium Carbonate.

Basic slag:

Basic slag can be mixed with Muriate of Potash,Sulphate of Potash,Sodium nitrate,Calcium cynamide and Calcium Carbonate. Basic slag can be mixed with Urea some time before using. Basic slag should not be mixed with Ammonium Sulphate,Calcium Ammonium Nitrate,Single Super Phosphate and Triple Super Phosphate and Ammonium phosphate.

Calcium Carbonate:

Calcium Carbonate can be mixed with Muriate of Potash,Sulphate of Potash,Calcium Ammonium Nitrate,Sodium nitrate,Calcium cynamide and Basic slag. Calcium Carbonate can be mixed with Urea some time before using. Calcium Carbonate should not be mixed with Ammonium Sulphate,Single Super Phosphate and Triple Super Phosphate and Ammonium phosphate.

CONCLUSION:

Before mixing the fertilizers everyone should be aware of their compatibility. With lack of knowledge improper mixing of fertilizers leads to yields and fertilizer losses.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Major Constraints of Citrus Production and their mitigation in North East India

Article id: 22825

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Citrus is an important group of fruits, commercially cultivated in more than 50 countries including different regions of India. North Eastern states viz. Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, Tripura and Sikkim are the home of citrus species like lime, lemon, mandarin, pummelo, sweet oranges, etc. Despite, having good potential in citrus production, North Eastern region of India face challenges due to biotic and abiotic stress like citrus decline, diseases and management related issues. High rainfall (6-7 months), hill slope cultivation, eroded and heavily leached soil of acid reaction, malnutrition, high infestations of insect-pests are typical in the region. The traditional mandarin orange cultivation of North eastern region is seedling origin and no rootstock is used. Use of proper rootstocks and adoption of management practices are crucial for citrus industry in the North East. Rough lemon rootstock and rangpur lime has been recommended as drought hardy alternative rootstock. The quality of the fruits is excellent, but the prevailing varieties are highly susceptible to diseases like Phytophthora. In heavy clay soils of Assam, Phytophthora disease is widespread. Shoot tip grafting (STG) and bud wood certification programme for supply of disease-free planting material plays an important role in mitigating the challenges of citrus production in the North Eastern region of India.

INTRODUCTION

Northeast India is recognized as one of the centers of origin of various Citrus species. It is one of the 25 global biodiversity hotspots accepted at present. This is also considered as the richest and one of the most endangered places for plant survival in the world. It is an important part of the Indo-Burma biodiversity hotspot. Citrus crops in northeastern region *viz. k*hasi mandarin, Assam lemon, Lime, Pummelo, Sweet oranges, etc. plays a vital role in the socio-economic development of the people in this region. Khasi mandarin is well known for its quality, fruit colour, unique sugar-acid blend and shelf life which make it the most popular citrus cultivar in northeastern region of the country. It covers the largest area in the region due to its commercial value. Assam and Meghalaya have the maximum area and production of Khasi mandarin. The health benefits of oranges have been well known for centuries, but it has therapeutic values that have long been utilized in conventional herbal medicine. Although India is fourth largest producer of orange in the world but due to the problem of citrus decline the average yield of orange in India is alarmingly low as compared to other countries. This review thereby summarizes the major constraints of citrus production and their mitigation measures in the northeastern region.

MAJOR CONSTRAINTS:

1. Marketing constraints:
   - ♣ Lack of reliable market information, regulation and distribution channels
   - ♣ High transportation cost
   - ♣ Lack of awareness about grading and different grades
2. Environmental constraints:

- Erratic onset of monsoon rain
- Long dry spells during winter lasting until flowering
- Heavy incidence of pests and diseases

3. Non availability of reliable & virus free planting material:
   - Lack of quality planting materials propagated from ideal mother trees is major constraint.
   - Lack of quality nursery that can provide good and virus free planting materials in the region.
4. Unsuitable rootstocks for specific situations
   - Non-Availability of rootstock for specific soil, climatic and environmental condition
5. Poor nutritional management
   - Nutritional disorders especially micronutrient deficiencies are frequently encountered in citrus orchards.
   - Lack of knowledge about the nutrient management of the crops and soil
6. Lack of Transport facilities
   - Hilly terrain and thus lack of transport facility is one of the major constraints.
7. Physiological problems due to environmental condition
   - Various physiological disorders like granulation, Fruit cracking, Citrus decline and fruit drop occurs due to unfavorable environmental condition.
8. Diseases and pest
   - Important insect-pests of citrus are citrus black fly and whitefly, citrus psylla, Citrus thrips, leaf miner, scale insects, bark eating caterpillar/trunk borer, fruit fly, fruit sucking moth, mites, etc.
   - The important diseases of citrus are *Phytophthora,* gummosis, citrus tristeza virus, citrus greening, citrus canker, powdery mildew, anthracnose, etc.
9. Post Harvest loss
   - Post harvest loss is a big issue of the region which is mainly due to lack of storage facilities like cold storage, etc.

MITIGATION MEASURES

Integrated approach is required based on the factors associated with the constraints.

- Strategies should include use of virus free planting material through Certified budwood supply program, Micro-grafting / Shoot tip grafting.
- Application of various fungicides, pesticides and insecticides like Bordeaux paste or copper oxifluoride paste or ridomil+carbendazim, monochrotophos, etc. at recommended doses.
- Careful selection of Rootstocks for specific situations and use of biotic and abiotic stress tolerant rootstocks like
- Timely management of nutritional needs, hormonal applications, use of organics, integrated pest and disease management, nematode control etc.
- Government's role in development of the better transport system, storage facilities to combat the post harvest loss of the citrus fruits is a need in urgent.
- Use of biotechnological methods to produce biotic or abiotic stress tolerant citrus rootstocks is another area of research which needs to be explored to enhance the productivity of the crop in this region.

CONCLUSION

Undoubtedly, citrus industry has enormous potential in the North east region. The significance of citrus crop is magnified not only because of its nutritional value but also owing to their medicinal use. Significant progress has been made in various research centers such as scientific cultivation of the crop, development of various *in vitro* shoot tip grafting protocols for the production of quality planting material, identification of important diseases and pests of the crop and its mitigation etc. Still there is a long way to go. Lots of budwoods have been imported by public and private organizations in this northeastern hill region during recent years. For such an introduction of planting material quarantine authorities should be highly vigilant. Budwood certification programmes in the North East region is an emergent need of the day so that appropriate planting material is used for raising orchards and the citrus grower of northeastern region can be able to increase productivity. After all, to make the available technology reaches to the farmers, the extension machinery should be more active.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Biology and Integrated Management of guava fruit fly (*Bactrocera* spp)

Article id: 22826

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INTRODUCTION:

Guava trees produce sweet smelling fruits with an edible rind, with a creamy white, yellow or pink flesh, when ripe guava release a sharp, musky odor that draws fruit flies. Fruit fly among the world's most serious pest of different horticultural crops due to their direct impact on economy. They are among the most destructive pests. They cause enormous damage to the production of fruit and vegetables throughout the tropical and sub tropical areas and cause both quantitative and qualitative losses. Monoculture of guava and use of improved agro techniques have lead to infestation by various insects pests which were earlier minor have now assumed status of major pests. Out of 80 species of insects pests recorded only few of them cause serious damage. These are bark eating caterpillar (*Indarbela* spp.), fruit flies (*Bactrocera* spp.), mealy bug (*Ferrisia virgata Cockerell*), scale insect (*Chloropulvinaria psidii* Maskell.), fruit broer (*Deudorix isocrates* Fab.) white fly (*Aleurodicus dispersus* Russell.) mosquito bug (*Helopeltis antonii* Signoret) and stem borer (*Aristobia testudo* Voet.) in different parts of country. Major insect pests and their management strategies are detailed below. (Muniappan *et al*., 2012)

Fruit Fly (*Bactrocera* spp):

Fruit flies (Diptera: Tephritidae) are among the most economically important pests attacking fruits found everywhere in the world **(Mun et al, 2003).** Guava fruits are mainly attacked by three species of fruit flies *viz*., *B. dorsalis, B. zonata and B. correcta* in all guava growing areas of country.

Biology:

Biology of fruit flies differs on the basis of climatic condition, availability of preferred host and natural bioagents. The life cycle of fruit fly especially *B. dorsalis* consists of three distinct larval instars. Larvae have got a characteristic jumping pattern of movement which serves as a defense mechanism. Adults generally mate at dusk.

Egg:

The adult females lay their eggs after searching for the suitable soft tissue of fruit. Females of *B. dorsalis* lay eggs in batches beneath the skin of the ripened or ripening host fruits 5-10 days after mating using her needle-like sharp ovipositor. A female can lay 10–30 eggs during each oviposition and can lay more than 1200 eggs during its lifespan. The egg is creamy white, spindle-shaped and measuring about 1 mm in length.

Maggot:

The maggot is a creamy white that caused damage to fruits by tunneling and feeding on pulpy content of the fruits. The maggots feed on the decaying fruit tissue. There are three larval stages and period ranged from 10-14 days.

Pupae:

Upon completion of larval feeding, the third instars larvae burrow into the soil and pupate inside a puparium at a depth of 6 cm. This transition from feeding to wandering occurred when the larva attained a critical nutritional or developmental status.

Adult:

After 8-10 days, adult flies emerge from the puparium and dig their way out of soil or debris. Adults fed on the host plants to obtain nutrient materials from nectar, dew, and fruit. By feeding on the host plants, the flies attain sexual maturity within 10-20 days and mate together to start a new cycle of damage.

Figure 1-Eggs of fruit fly fruit fly

Figure 2-Larva of fruit fly

Figure 3-Pupae of fruit fly

Figure 4-Adult of fruit fly

Total developmental period:

Total life cycle ranged about 1-2 months. Being facultative breeders and having a short life cycle, fruit flies are multivoltine in nature having more than one generation per year. *B. dorsalis* can complete 3-5 generations per year. It completes 5-10 generations in a year in tropical areas and less than 4 in subtropical areas.

Integrated management of fruit fly

- Collection and destruction of infested fruits.
- The cultivar Lucknow-46 exhibits high resistance against *B. dorsalis.*
- Ploughing around the tree basins to expose pupae to sun's heat and natural enemies.
- A mixture of protein hydrolysate and malathion (0.1-0.25% + 0.05%) as cover spray on host trees is useful in killing of adult flies.
- Fruits should be harvested at proper maturity and ripened fruits should be removed from the plant.
- Methyl eugenol wooden block traps soaked in ethanol, methyl eugenol and malathion (6:4:1) for 72 hrs should be hung on trees @ 10 traps ha^{-1} during fruiting period.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

IPDM: a solution for doubling farmers' income

Article id: 22827

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INTRODUCTION:

Integrated Pest and Disease Management (IPDM) can be defined as the use of all available need-based strategies i.e. cultural, physical, biological, genetic and chemical, to reduce the disease and pest populations under economic threshold level for huge production of agricultural crops without causing any ill effects to the environment, thereby maintaining the sustainability. One important thing about chemical method is that we have to take it only when other practices will fail to protect the disease or pest.

HOW TO DOUBLE FARMER' INCOME?

IPDM will maintain the sustainability of ecosystem and increase the productivity. Central government has announced a huge plan to double income for farmers in India by 2022. During 2016-17 the food grain and both fruits & vegetables production of India was 278 million tonnes and 300 million tonnes respectively. The record production was mainly due to favourable monsoon season after two consecutive years of low rainfall. Marginal and small land holdings are the main reasons for low income in our country. In India, over 66% of farm households is having land less than one hectare. Because of this although the crop productivity level is high per farmer but the overall income is very low. We all know that farmers are the pillars of food production, therefore one of the ways to achieve this huge task of doubling farmers' income is by helping farmers in reducing crop losses due to attacks by pests and diseases and improve productivity of their crops which will in turn help multiply their income.

Around 16-26% of food produced by the farmers were destroyed by pest and diseases. By seeing these increased damage farmers tend to go for application of hazardous agrochemicals. The examples worth mentioning are whitefly infestation of Bt-cotton crop in North India last year and also the serious infection of BPH in rice in Odisha during last two years.

Application of chemicals is not a feasible approach because of its high cost, low efficiency and residual toxicity. Resistance against pest and diseases is also not every effective due to its high cost and increasing diversity among pest and diseases. Long-term toxicity of chemicals and limitation of target sites is a concern for scientist around the world. To find sustainable eco-friendly approach for controlling pest and diseases scientist has diverted to the application of bio-control agents. Integrated Pest and Disease Management is one of the modern approaches to increase farmer income while protecting the environment by combining all the feasible methods i.e. cultural, biological, physical, mechanical, legal and need based chemical control measures.

IPDM helps reducing the problem of pest resistance or resurgence, maintains crop quality, reduce pest infestation which in turn will lead to higher crop yield. Thus, IPDM is an sustainable approach, which can be defined as "production of more output from the same land without causing much negative environmental impacts and simultaneously increasing environmental capital"

Although IPDM is very cost-effective in nature but there is very less policy support for the farmers. Although many developed countries have realised the importance of IPDM as a sustainable eco-friendly approach but India is still lagging behind.

In addition to all the IPDM strategies we should go for climate smart agriculture by proper application of Artificial Intelligence and Machine Learning in agriculture as the climate is changing day by day. There should be diversification of high value crops, efficient use of resources, lowering down the cost of production by improving the actual prices being received by farmers by assuring the minimum support price will give confidence to the farmers to take up something new which will ultimately help in increasing farmers income.

CONCLUSION:

The phrase "doubling of farmers' income by 2022'' sounds quite good theoretically but the real challenge is quite tough and it is us being a student of agriculture we should create awareness among the people in India and the Scientific community along with Government should give a helping hand to make this dream come true by making India self-sufficient in food production.

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e-ISSN: 2581 - 8317
Volume 2 – Issue 2 – February 2020

AGRICULTURE & FOOD
e - Newsletter

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Characterization and Medicinal Properties of Propolis

Article id: 22828

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INTRODUCTION:

The term propolis derives from the Greek pro (for 'in front of', 'at the entrance to') and polis ('community' or 'city') and means a substance in defense of the hive. Propolis, or bee glue, is a brownish resinous material collected by worker bees from the leaf buds of numerous tree species like birch, poplar, pine, alder, willow and palm. In order to manufacture propolis, bees may also use material actively secreted by plants, or exuded from wounds in plants lipophilic material on leaves, mucilage's, gums, resins, lattices, etc.). Once collected, this material is enriched with salivary and enzymatic secretionsw1xand is used by bees to cover hive walls, fill cracks or gaps and embalm killed invader insects. Modern herbalists recommend it for its anti-bacterial, anti-fungal, anti-viral, hepatoprotective and anti-inflammatory properties, to increase the body's natural resistance to infections and to treat gastro duodenal ulcers. Applied externally, propolis relieves various types of dermatitis caused by bacteria and fungi. Today propolis is currently used as a popular remedy and is available in the form of capsules (either in pure form or combined with aloe gel and rosa canina or pollen), as an extract (hydroalcholic or glycolic), as a mouthwash (combined with melissa, sage, mallow and/or rosemary), in throat lozenges, creams, and in powder form (to be used in gargles or for internal use once dissolved in water). It is also available commercially as purified product in which the wax has been removed. Propolis is also claimed to be useful in cosmetics and as a constituent of health foods.

Chemical Constitutes of Propolis:

Up to now, more than 180 compounds, mainly polyphenols, have been identified as constituents of propolis. The major polyphenols are flavonoids, accompanied by phenolic acids and esters, phenolic aldehydes, ketones, etc. Other compounds in propolis are volatile oils and aromatic acids (5–10%), waxes (30–40%), resins, balms and pollen grains which are a rich source of essential elements such as magnesium, nickel, calcium, iron and zinc. New compounds have also been isolated from Brazilian (3,5-diprenyl-4-hydroxycinnamic acid)and Chinese(octa-cosanol)samples of propolis. While the chemical composition of propolis has been clarified to some extent in recent years, there still remains one problem which is the striking variability of its chemical composition depending on the site of its collection. Anti-microbial properties of propolis seem attributable mainly to the flavonoids pinocembrin, galangin and pinobanksin. Pinocembrin also exhibits anti-fungal properties. Other active compounds are ester of coumaric and caffeic acids. Of the other compounds, prenylated p-coumaric and diterpenic acids possess anti-bacterial and cytotoxic activities. Caffeoylquinic acid derivatives show immune modulatory and hepatoprotective actions and furofuran lignans inhibit the growth of some bacteria. Caffeic acid phenethyl ester (CAPE) is also cytotoxic towards tumor cells.

Properties of Propolis:

Propolis being extremely high in bioflavonoid content has antioxidant, antibacterial, antifungal, antiviral and anti inflammatory properties. Other properties of propolis include acting as a local anesthetic, reducing spasms, healing gastric ulcers, and strengthening capillaries. Propolis can be used by humans internally or externally.

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- **Antimicrobial Properties:**

The mechanism of antimicrobial activity of Propolis is complex and could be attributed to the synergistic activity between phenolic and other compounds mainly to the flavonoids pinocembrin, galangin, and pinobanksin. A stronger activity was observed on gram-positive bacteria growth. The antimicrobial activity was observed on Staphylococcus aureus, Streptococcus pyogenes, gram-positive and gram-negative bacteria species and Candida, Streptococcus mutans anaerobic bacteria of human oral cavity and on miscellaneous microorganisms including Mycobacterium. It partially inhibited growth of Pseudomonas aeruginosa and Escherichia coli but had no effect on Klebsiella pneumoniae. Thus it appeared to have a preferential inhibitory effect on cocci and Gram-positive rods. Enterococcus spp., Corynebacterium spp. Ethanolic extracts of sample (conc. 200mg/mL) showed high antibacterial activity against Gram-positive, that is, Bacillus subtilis, but least activity against Gram-negative bacteria (P. aeruginosa and E. coli). The yeast C. albicans showed themoderate zone of inhibition whereas A. Niger did not show any activity. However, the least was in the 40% methanolic extracts.

- **Antifungal Activity:**

Propolis has shown fungicide effects on juice spoilage fungi *Candida famata, C. glabrata, C. kefyr, C. pelliculosa, C. parapsilosis,* and *Pichia ohmeri* the fungicidal effect was associated with the presence of flavonoids . Propolis is the bee product with the highest antifungal activity as tested with 40 yeast strains of *C. albicans, C. glabrata, C. krusei,* and *Trichosporon* spp. The most resistant strain was *C. Albicans*. In an unpublished study in Bangalore, Indian propolis has been observed to be more effective than routinely used anticaries agents in inhibiting the growth of *Streptococcus mutans* which is a frequent cause of dental caries .Oliveira et al. (2006)was studied the 67 samples of yeasts isolated and identified from samples of onychomycosis comprising the following species: *Candida albicans*, *Candida parapsilosis*, *Candida tropicalis*, *Candida kefyr*, *Candida guilliermondii*, *Candida lusitaniae*, *Candida glabrata*, *Candida stellatoidea*, *Candida Trichosporon* sp. including *T. asahii*, *T. ovoides,* and *T. cutaneum*, one *Geotrichum candidum,* and three *Saccharomyces cerevisiae*. *Trichosporon* sp. was the most sensitive species.

- **Anti Cancer Properties:**

Ethanol extracts of propolis have been found to transform human hepatic and uterine carcinoma cells in vitro, and to inhibit their growth. Propolis was also found to have a cytotoxic and cytostatic effect in vitro against hamster ovary cancer cells and sarcoma-type tumours in mice. A substance called Artepillin C has been isolated from propolis, and has been shown to have a cytotoxic effect on human gastric carcinoma cells, human lung cancer cells and mouse colon carcinoma cells in vitro.

- **Anti Oxidant Properties:**

The flavonoids concentrated in propolis are powerful antioxidants. Antioxidants have been shown to be capable of scavenging free radicals and thereby protecting lipids and other compounds such as Vitamin C from being oxidized or destroyed. It is probable that active free radicals, together with other factors are responsible for cellular aging and degradation in such conditions as cardiovascular diseases, arthritis, cancer, diabetes, Parkinson disease and Alzheimer disease. Oxidative damage may also result in poor liver function. Studies on rats in vitro show that propolis extracts protect against damage to liver cells.

- **Antiprotozoan Activity:**

Antiprotozoal activity is evaluated by an in vitro growth inhibitory effect on a culture of parasites after incubation in the presence of different concentrations of propolis. The effect of European propolis on protozoa reported by several publications that cause diseases in humans and animals such as trichomoniasis, toxoplasmosis, giardiasis, Chagas disease, leishmaniasis, and malaria. Indeed, antiprotozoan activity has also been reported on *Giardia lamblia, Trichomonas vaginalis, Toxoplasma*

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gondii, Leishmania donovani, and *Trypanosoma cruzi*. Also an antiprotozoan activity of EEP was reported against *G. duodenalis*.

- **Antidiabetic Activity:**

The effect of ethanolic extract of propolis against experimental diabetes mellitus-associated changes was examined. Diabetes was induced experimentally in rats by i.p. injection of streptozotocin (STZ) in a dose of 60mg/kg between for 3 successive days. Blood urea nitrogen (BNU), creatinine, glucose, lipid profile, malondialdehyde (MDA), and urinary albumin were measured. Superoxide dismutase (SOD), glutathione (GSH), catalase (CAT), and MDA were measured in the renal tissue. The results showed decreased body weight and increased kidney weight in diabetic animals. Compared to the control normal rats, diabetic rats had higher blood glucose, BNU, creatinine, total cholesterol, triglycerides, low-density lipoprotein-cholesterol (LDL-C), MDA and urinary albumin, and lower high-density lipoprotein-cholesterol (HDL-C) levels. Moreover, renal tissue MDA was markedly increased while SOD, GSH, and CAT were significantly decreased. Oral administration of propolis extract in doses of 100, 200, and 300mg/kg between improved the body and kidney weights, serum glucose, lipid profile, MDA, and renal function tests. Renal GSH, SOD, and CAT were significantly increased while MDA was markedly reduced. These results may suggest a strong antioxidant effect of propolis which can ameliorate oxidative stress and delay the occurrence of diabetic nephropathy in diabetes mellitus.

CONCLUSIONS:

Various studies on Propolis have established that it can be used as a therapeutic agent. Propolis can be used in the treatment of many serious systemic diseases caused by bacterial infections and chronic fungal infections. Dental caries can be effectively treated and prevented by using Propolis formulations. Propolis may be incorporated in toothpaste, mouth rinse etc to maintain the oral hygiene in patients. The anti cancer and anti oxidant properties of Propolis make it a novel drug for cancers and aging.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Biology, Symptoms and Use of Entomopathogenic Nematodes for Management of Insect Pests

Article id: 22829

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INTRODUCTION:

Nematodes that parasitize insects, known as entomopathogenic nematodes (EPNs), have been described from 23 nematode families. Biological control is a good-looking alternative which is environmentally safe and feasible in crop protection. Entomopathogenic Nematodes (EPNs) are bio-control agents which are effective for the management of insect pests. Two genera, *Steinernema* and *Heterorhabditis* are highly virulent EPNs, use as classical, conservational and augmentative biologicalcontrol organisms of soil dwelling and above-ground pests. These Entomopathogenic Nematodes killing the insect host within 1-2 days. The indiscriminate uses of pesticides in agriculture have hazardous effects on environment. There is avital need for methods that are eco-friendlymanagement. Development of resistance and coming out of new biotypes is another concern about using chemical pesticides which force us for a change in pest management methods.

Biology and life cycle of entomopathogenic nematodes:

Both nematode genera(*Steinernema* and *Heterorhabditis*) reproduction is amphimictic in the second generation. Only the IJ stage (free-living) is able to target insect host and the only form found outside of the host. EPNs occur naturally in soil and find their host in response to CO_2, vibration and other chemical cues from the host, and they react to chemical stimuli or sense the physical structure of insect's integument.

IJs penetrate the host insect by passing through the spiracles, mouth, anus, or in some species through intersegmental membranes of the cuticle, after that enter into the haemocoel. IJs release cells of their symbiotic bacteria from their intestines into the haemocoel. The symbiotic bacteria multiply rapidly in the insect haemolymph, which provide nutrition to the nematode and prevent secondary invaders from contaminating the host cadaver, and the infected host usually becomeparalyzed and dies within 24–48 hours by bacterial toxins.

Nematodes reproduce food supply until they becomes limiting at which time they turn into IJs. The progeny of nematodes go through four juvenile stages to the adult. Based on the accessible resources, one or more generations of EPNs may occur within the host cadaver, and a huge number of IJs are released into environment to infect other insects host and continue their life.

Symptoms:

Steinernematids nematodes, infected larvae turn creamy/dark brown colour and Heterorhabditis nematodes infected larvae will turn reddish/purplish colour. The colour of the insect host body is indicative of the pigments produced by the monoculture of mutualistic bacteria growing in the host insects.


Figure-1:Steinernematids infected larvae


Figure-2:Heterorhabditis infected larvae

Searching Behaviour:

The EPNs use two main foraging strategies which are change between the species: ambushers or cruisers.

Ambushers: Have an energy-conserving approach and lie-in-wait to attack mobile insects in the upper soil such as army worm, cutworm, etc. eg. *Steinernema carpocapsae*

Cruisers: Highly active and generally subterranean, moving significant distances to find their host underground. Therefore, they are effective against less mobile pests such as white grubs (Scarab beetles). e.g. *Steinernema glaseri* and *Heterorhabditis bacteriophora.*

Other species, such as *Steinernema feltiae* and *Steinernema riobrave*, use an intermediate searching strategy (combination of ambush and cruiser type) to find their host.

Factor affecting selection of entomopathogenic nematodes:

Selection of an EPN to control a particular insect pest is based on various factors *viz*. host range, host finding or foraging strategy, tolerance of environmental factors and their effects on survival and efficacy. The most critical factors are moisture, temperature and pathogenicity for the targeted pest and foraging strategy. The infectivity and survival of EPNs can be intensely influenced by soil composition like-moisture retention, oxygen supply and texture.

Table 1: Commercially used nematode formulation

Name of Nematode Formulation	Targeted Insects	Trade Name of Formulation
Steinernema carpocapsae	Lepidopterous larvae	X-Gnat, Nemastar, Bio-safe
Heterorhabditis bacteriophora	Soil-dwelling insects	Nema Green, nema Top, Hetromask
Steinernema feltiae	Dipterous insect	Magnet, Entonem, Nemasys

Advantages of EPNs:

- Foliar applications of nematodes have been successfully used to control the quarantine leaf-eating caterpillars as *Tuta absoluta*, *Spodoptera littoralis*, *Helicoverpa armigera, Pieris brassicae* and various other insect pests on several crops.
- EPNs and their associated bacterial symbionts have been proven safe to warm-blooded vertebrates, including humans
- Most biological agents require days or weeks to kill the host, yet nematodes can kill insects usually in 24–48 hours
- Their high degree of specificity protects beneficial insects.
- The method is self sustaining& so economical.

- They are effective in very slow doses and compatible with many chemical insecticides.

Disadvantages of EPNs:

- They kill only one insect- pest.
- The method depend on environmental factors, failure cannot be unavoidable.
- The necessity of correct timing of application with respect to the incubation period of the diseases.
- Results are not as quick as in insecticides.

CONCLUSION:

The use of EPNs for control of insect-pests is most suitable and they are highly specific and harmless to the other life.They are effective in very slow doses with slow mode of action.The use of EPNs agent isnon-polluting to environment & no adverse effect on any biological system.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Origin, Production, Varieties, Package Of Practices For Okra

Article id: 22830

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INTRODUCTION:

Fruits are important and used as vegetable in India, Brazil, Weat Africa and many other countries. Tender green fruits are cooked in curry and are also used in soups. The rootand stem are useful for clearing cane juice in preparation of jaggary. Okra is said to be very useful against genitor-urinary disorders and chronic dysentery. India is the largest producer of okra in the world. The major okra growing states are Uttar Pradesh, Odisha, Bihar, Andhra Pradesh and West Bengal. Fresh okra is an important vegetable which is exported from India to Middle East U.K., Western Europe and USA.

Climate:

It requires warm and humid conditions for good growth. It is susceptible to low temperature. It can be grown successfully under the temperature ranging between 25– 30o C. The okra plants grow taller in the rainy season than in the warm summer. For seed germination optimum soil temperature and a temperature range between 25 C and 35o C is required, with fast germination observed at 35o C. Seeds fail to germinate below 17o C. At temperature above 42o C flower buds in most of the cultivars may desiccate and crop causing yield losses.

Soil:

Sandy to clay soils, so long as those are well manured, supplied with enough organic matter and with good drainage are fit for okra cultivation. For best yield, soil pH should range between 6.0 and 6.8, because maximum nutrient uptake through roots, in most of the cultivars. However, Pusa Sawani is adopted to larger pH range and has some tolerant to salinity.

Land preparation:

The land should be well prepared by one deep ploughing and 3-4 normal ploughings. The plant has well developed tap root system and is a heavy feeder and as such the soil should also be made rich in organic matter content. Well rotten farm yard manure should be incorporated at soil preparation. The total amount of phosphorus, potash and half of nitrogen should be added at the time of final preparation of soil. Level the soil at last ploughing.

Sowing season and seed rate

i. Spring-summer (beginning of February to the end of March) – 18-22 kg/ha
ii. Rainy season (May- July) – 8-10 kg/ha

Method of sowing and spacing:

Okra gives little success on transplanting and thus seed is sown directly in the soil by seed drill, hand dibbling or behind the plough. Broadcasting is not recommended due to high seed rate as well as inconvenience in cultural operations and harvesting. Sowing on ridges ensures proper germination, economizes irrigation water during spring summer and helps in drainage during rainy season. It is always better to do seed sowing in a moist-soil than irrigating the field after sowing.

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The vegetative growth during spring summer is relatively less, hence a distance of 45 x 20 cm is recommended. For May- July sowing, a distance of 45-60 cm between rows and 25-30 cm between plants is considered the best.

Manuring and fertilization:

The crop is manured with FYM@ 15-20 tons/ha andN:P:K @ 125:75:60 kg/ha. One third N along with other fertilizers should be given as basal and rest N should be top dressed in two split doses at 30 days after sowing and at flowering.

Irrigation:

Seed should be sown when the soil is moist. First irrigation is required at the initiation of first true leafduring spring summer and its expansion during kharif (rainy) season.After fruit setting, water requirement is critical. Flooding or wilting of plants should be avoided.Drip gives considerable yield increase and saves 70-80 % irrigation water.

Training/ pruning:

Ratoon crop in kharif from plants of spring-summer sowing by pruning them at 20-25 cm height. Arka Abhay and Pusa A-4 are suitable for ratoon crop as given quick branching after pruining.

Harvesting and yield:

In general, harvesting every alternate day is advisable. It takes 7-8 days from flowering to picking of fruits. Generally the consumer prefers small tender fruits of 7 to 10 cm long.

An average yield of 8 tonnes green fruits per hectare during spring-summer and 12.5 tonnes during rainy season is ideal.

INSECT PESTS

Shoot and fruit borer (Earisvittella): Larvae bore into the fruits which become unmarketable and cannot be used for human consumption. The larvae bore into the growing shoot initially and fruits at later stage. It is the major pest of okra.

Control:

1. Good management practices, first adopt the preventive tactics followed by curative tactics.

2. Summer ploughing and clean cultivation are also helpful in reducing the pest population.

3. Follow the crop rotation excluding cotton and hollyhock.

4. Regularly remove the attacked fruits and bury them deep into the soil.

5. Spray carbaryl (0.2%) or cypermethrin (0.05 %) at fortnight interval.

Whitefly (*Bemesia tabaci*). The insect do not cause considerable damage to the crop but act as vector to transmit the yellow vein mosaic virus disease.

Control:

1. Follow good crop rotation with crops who are not affected by jassids

2. Use of biocontrol tactics by releasing predators. 3. Spray the crop either malathion (0.1 %) or dimethoate (0.03%) or monocrotophos (0.05%) starting from the attack of insect.

DISEASES

Yellow vein mosaic virus is often sever in Northern India, while powdery mildew is a serious disease in the southern part of India. Yellow vein mosaic virus disease is almost a limiting factor for successful cultivation of okra in India.

Yellow vein mosaic: This viral disease is characterized by yellowing of veins. In extreme cases the entire leaf turns completely yellowing colored. The infected plants remain stunted and bear very few, yellow coloured fruits. The virus is transmitted by white fly (Bemisiatabaci).

Control:

1. Grow resistance varieties like ParbhaniKranti, VarshaUphar, PanjabPadmini, ArkaAbhay, ArkaAnamika etc.

2. Destruction of weed hosts, whenever possible, should also be given importance**. 3.** Rogue out the diseased plants from the fields as earliest as possible.

4. Control white fly by spraying malathion (0.1%) or dimethoate (0.05%) at an interval of 10-15 days.

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AGRICULTURE & FOOD: e- Newsletter
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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Mulching and it's role in Vegetable Crops

Article id: 22831

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INTRODUCTION

Mulch is a general term for a protective ground cover that can include manure, wood chips, seaweed, leaves, straw, grasses, sands, stones (boulders), synthetic plastics, and other natural products. While the term mulching may be defined as a practice of covering the surface of soil with these materials to reduce evaporation, and also to moderate wide fluctuations in diurnal soil temperatures, especially in the root zone environment. It controls external evaporability and also reduces energy supply to the evaporating site by cutting off solar radiation falling on the ground. *Its main function is limited to controlling first stage of drying which helps in improved moisture status, reduced soil temperature* (Loy and Wells, 1975), besides checking seedling mortality and improving crop stand. It also suppresses weed-flora and reduces weed competition with crop for water and nutrients making them available in greater quantities for crop plants. Besides the above, mulching helps in increasing downward movement of water.

Mulch is used for various purposes / Main objectives

1. To accent landscape plantings.
2. To provide a "finished" look to the garden.
3. To help in production of clean and quality products.
4. To protect the plant and their produce from attack of insect-pest and diseases.
5. To moderate the soil thermal regime throughout the cropping season.
6. To prevent weed growth.
7. Increasing overall crop production.
8. To improve the fertility of soil.

Types of mulches

There are of two basic types viz., organic and non-organic mulches. The examples of only those mulch materials have been explained below which are mostly used in vegetable productions.

Organic mulches:

Compost/Manure/peat

These materials can be used for mulching and can be of quite an attractive appearance. They need to be laid in a 2" – 3" thick layer. Manure should be well rotted before laying or damage can occur to plants. These materials will benefit the soil fertility. It is generally considered as the best mulching material for the home garden. It is usually free of weed seeds and is inexpensive. It may be highly satisfactory where available from commercial producers or homeowners. One can prepare compost from materials present in his yard. It is not necessary to purchase expensive materials for mulching.

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Peat moss

This mulch is attractive and easy to handle but somewhat expensive. Dry peat moss requires considerable time and water to become moist, so it should be applied only to a 3-inch or less depth and avoided in areas subject to drought. Its acidic pH makes it especially desirable for acid-loving plants.

Sawdust

Aged partially rotted sawdust makes satisfactory mulch that lasts a long time. Since it is prone to caking and has a high carbon to nitrogen ratio. It contains only half the nutrients of straw, is slow to break down and causes nitrogen robbery, so should not be incorporated into the soil unless and until it has broken down to a brown 'soil' and worms are found in it. Softwood sawdust takes longer than hardwoods to decompose.

Straw

Straw has similar qualities to grass clippings provided that that it should be put down in a thick layer (5-10 cm).

News paper

Apply sheets of newspaper and cover lightly with grass clippings or other mulch material to anchor. They are impractical on their own, as they are too prone to blow away and once wet are soon broken up or penetrated by weeds. Newspaper is mostly chlorine-free and there is no danger to lead from the ink any one. If other mulch materials are not available, cover edges of paper with soil. Applying on a windy day can be a problem. This is certainly readily available and economical but somewhat difficult to apply. A good use for newspaper is as an under mulch; that is, place two to three sheets under a thin layer of an attractive, more expensive mulch. They can be useful underneath loose mulches, as they stop the soil being mixed commercial papers are available.

Non-organic mulches:

Polyethylene mulches

Non-organic mulches generally lack the soil improving properties particularly to improvement in soil particle aggregation, structure formation and regulation of soil reactions. Among the different inorganic mulches, the use of plastic mulches is most common owing to its properties of moderating the hydrothermal regimes of microclimate of crops, show positive effects on weed control, prevention of soil dryness and crusting, water saving by preventing evaporation from surface, prevention of soil erosion and reduction of nutrient loss by leaching.

Types of plastic materials

The plastic materials may be either PVC or polyethylene. Owing to its greater permeability to long wave radiation which can increase the temperature around the plants during the night times, polyethylene is preferred.

Aluminum-coated plastic and foil

Use is limited primarily to vegetable plants where research findings have indicated a significant reduction in insect pests, such as aphids, and viruses carried by insects. One layer of either one of these materials provides excellent weed control. These materials decompose very slowly, but they are very expensive and quite unattractive mulches.

When to apply mulch?

Time of application depends on what we want to achieve by mulching. Mulches, by providing an insulating barrier between the soil and the air, moderate the soil temperature.. If you are using mulches in vegetable garden or flower garden, it is best to apply them after the soil has warmed up in the spring. Cool, wet soils tend to slow seed germination and increase the decay of seeds and seedlings.

Role of organic mulching in vegetable production;

- **Crop nutrition/fruit quality**

Mulches of organic origin have been reported to be effective in increasing the leaf and fruit nutrient concentrations of vegetable crops due to better moisture regime and optimum soil temperature in the root zone of plant. Pertaining to the higher availability of phosphorus concentration in the plant leaves under organic mulches it is observed that because of increment of soil solution phosphorus on partial decomposition of organic mulches *inter-alia* better surface rooting of the crops and keeping the surface soil moist for a longer time. The concentrations of ascorbic acid, B-carotene and vitamin-A are also recorded to be appreciably higher in the fruit of brinjal plants growing with *Cordia* leaf mulch as compared to the bare field

Role of plastic mulching (Non-organic mulching) in vegetable production

- **Soil fertility**

The use of black polyethylene mulch in vegetable production has been reported to control the weed incidence, reduces nutrient losses and improves the hydrothermal regimes of soil. Polyethylene mulches also buffer soil pH and exchangeable Mg and Ca more efficiently than the uncovered soil. Many researchers have revealed that yield of tomato was significantly higher in polyethylene mulched soil as compared to uncovered soil probably as a result of slowing soil-water percolation and restricting removal of nutrients from the top 15-cm of soil.

- **Soil water conservation**

Covering the soil surface with plastic film reduces the irrigation requirement in bell pepper (*Capsicum* sp) by 14-29% due to elimination of soil evaporation. Tomato plants growing in polyethylene mulched soil have shown improved water use efficiency and yield potential under all (surface and drip) levels of irrigation. Mulching experiment conducted on brinjal crop with black polyethylene revealed that it conserved 29-56 and 22-107% more moisture as compared to straw mulches and control, respectively (Singh *et al*. 2006).

- **Plant growth and yield**

It has been demonstrated that black polyethylene mulch is found to be beneficial in promoting early harvest, higher plant biomass and yield of muskmelon relative to plants grown without mulch. The yield of brinjal plants mulched with white and black polyethylene is recorded to be increased by 344 to 520% over control probably as a result of slowing the soil-water percolation and restricting removal of nutrients from the top 15-cm of soil (Singh *et al*. 2006). Red and black plastic mulches which induce higher soil temperature have been found to be more effective in increasing the early yields of tomatoes than the white and reflective plastics (Decoteau *et al*., 1989).

Advantages of mulching: The introduction of mulching into your garden will provide the following rewards:

1- Prevention of weed growth.
2- Soil will retain more moisture.
3-Prevention of erosion.
4-Improved soil conditions and healthier plants.
5-Will encourage beneficial organisms such as earthworms to the soil.
6-The mulch acts as a fertiliser.
7-less weeding and watering necessary.

Disadvantages of mulching

Mulches do have a few drawbacks, which are as follows:

(i) The cost of some materials can be a drawback to large-scale mulching.
(ii) Some mulch is not readily available.
(iii) In case of sawdust or straw mulch, nitrogen starvation sometimes occurs.
(iv) Heavy mulching over a period of years may result in buildup of soil over the crown area of the plants.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Recent developments in management of diseases caused by geminiviruses

Article id: 22832

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INTRODUCTION:

The family Geminiviridae consists of a group of plant viruses with circular single-stranded DNAs (ssDNAs) which cause great economic losses to crops worldwide. The geminivirus family of single-stranded DNA viruses causes a broad range of field crop diseases that incur significant agricultural losses throughout the tropical and temperate regions of the world. Geminivirus particles are made up of a DNA molecule encased within a capsid consisting of many copies of a single coat protein. Virions are typically twinned (so-called "geminate"). For maize streak virus (MSV) particles, cryo-electron microscopy has shown that virions are about 22 x38 nm, consisting of two incomplete icosahedra (T =1) containing a total of 110 coat protein subunits organized as 22 pentameric capsomers Independently replicating plant viruses with the smallest known genome size ranging from 2.6-3.0 Kb. Virions contain a single structural protein (CP; Mr about 28–34*10^3). No other proteins have been found associated with virions. Viruses in the genera *Mastrevirus*, *Curtovirus, Becurtovirus, Eragrovirus,Turncurtovirus* and *Topocuvirus* have a single genomic component, whereas those in the genus *Begomovirus* have either one or two components. Replication occurs through double stranded replicative intermediates by a rolling circle mechanism. Complementary-sense DNA synthesis on the virion-sense (encapsidated) strand to produce dsDNA depends solely on host factors. Geminiviruses causes many diseases. Some of the important diseases caused by geminiviruses are Maize streak disease, cotton leaf curl, cassava mosaic, mungbean yellow mosaic, chilli leaf curl, bean golden mosaic, tomato leaf curl, beet curly top etc.

Management strategies:

Management of viruses is difficult as viruses are systemic in nature, highly variable or diverse, insect vector etc. Geminiviruses can be managed by different practices.

1. Cultural practices: Begomoviruses as a group have a wide host range which may be explained by the voracious feeding habits of the vector. However, single viruses may have a very restricted host range. Once conditions are favorable for feeding and ovipositing, whiteflies have a high reproductive rate and can exist in overlapping generations year-round, maintaining disease pressure. Interestingly, the dry season seems to encourage the explosive number of whiteflies in some farms. This presents a challenge to devising control and/or suppressive strategies for disease management. While complementary cultural practices may not totally prevent spread, infection may be delayed and the effects of viral disease may be lessened throughout the crop. For *Tomato yellow leaf curl virus* (TYLCV), another begomovirus, weeds act as a reservoir or "transmission bridge" between cropping and non-cropping seasons. **Rigorous weed control** in and around tomato fields may reduce inoculum of other important tomato-infecting viruses such as *Tobacco etch virus* (TEV) and *Tobacco mosaic virus* (TMV), this approach may have minimal impact on controlling PYMV-TT disease spread.

Trap crops are commonly used to restrict vector populations and virus sources to refuge host plants which are usually insusceptible to infection. Certain plants within the Brassicacae family are susceptible to heavy whitefly infestation. In controlled preliminary transmission tests, it was shown that whiteflies seem to prefer cabbage more than tomato. Planting border rows of cabbage along the perimeter of, or situating cabbage fields next to tomato fields may localize feeding to these crops as shown by studies conducted with TYLCV in Israel.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Intercropping may provide a useful approach to controlling geminivirus disease spread. Planting an insusceptible crop such as cucumber or pumpkin with tomato may delay PYMV-TT infection in tomato. Intercropping systems would affect several factors that may be critical to disease management. In the presence of a variety of host plants, whitefly behavior (feeding, rate of movement between plants) becomes more sporadic. Shorter feeding times may lower transmission rates and reduce disease incidence in the affected crop. It has also been shown that intercrops may result in a decrease in whitefly populations in *Cassava mosaic virus* (CMV) epidemics.

Crop rotation may be used to control disease spread by naturally breaking the life cycles of insect vectors, disease, and weeds. It may be also employed to establish host-free periods. Enforced host-free periods have been shown to effectively reduce disease incidence in TYLCV-infected tomato in the Dominican Republic.

Introducing a host-free period may delay infection in tomato until the later stages of crop development because: (i) whitefly population would be reduced once a non-preferred host is used as an alternate crop; (ii) a reduction in vector numbers would result in lower rates of virus transmission; (iii) initial vector numbers would be lowered until tomato becomes established (early to mid-flowering stage) which may cause a delay onset of infection and minimize yield losses.

Sequential plantings should be carefully monitored so that new tomato fields are not cultivated near heavily infested but still productive fields and to harvested fields. In agroecosystems in which the tomato crop is the inoculum source, synchronized plantings may be important to disease management. Sufficient time should be allowed between plantings to minimize initial infestation by the vector, and so, to delay onset of infection.

The source and use of crop transplants are also important in reducing or delaying infection. Early infection of susceptible seedlings should be monitored prior to transplanting. In Trinidad, the majority or large farms purchase seedlings to be transplanted to the field from local growers. Nurseries should produce seedlings for commercial distribution in insect-proof environment or under net cover to minimize infestation by the vector, and subsequent virus transmission prior to transplanting. Upon transplanting, the seedlings should be chemically treated to deter whitefly feeding.

Roguing or immediate removal of infected individual plants, may assist in delaying virus spread once the infected material is immediately destroyed and not left to compost near adjacent, developing fields. Plants heavily infested with whiteflies may need to be bagged, and tied off prior to uprooting and discarding to eliminate dispersal of whiteflies to other plants. Sufficient irrigation may reduce water stress. While flash irrigation may be useful in dispelling whiteflies from leaves, many farmers cannot afford such systems.

The use of row covers and reflective or repellent mulches may help to delay infection in cases of moderate vector numbers and infection rates. The efficacy of these measures may be optimal in newly developing fields to prevent early onset of infection. Mulches should be applied simultaneously with or immediately after transplanting. Physical barriers such as fine-mesh screens have been used in the Mediterranean Basin since 1990 to protect crops from TYLCV (Berlinger & Lebiush Mordechi, 1996; Berlinger et al., 2002; Cohen & Antignus, 1994).

Post-harvest practices are important in controlling disease spread since whiteflies continue to develop on infected plants after the crop has been abandoned. Harvested plants should be sprayed and destroyed immediately after the last harvest.

2. Chemical control:

Apart from damage caused by viral infection by geminiviruses, vector infestation can result in feeding damage, disruptions in plant physiology, honeydew secretions which serve as a substrate for secondary

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

fungal infestations, and irregular fruit ripening which reduces the value of the produce. Focused cultural methods of disease suppression should be supplemented with regulated chemical use. The difficulty experienced with reducing vector numbers using chemical sprays is explained by the behaviour (feeding, ovipositing, and mating) of the adult, nymphal, and larval forms of the whitefly. Nymphs and older larvae are found in the lower regions of the plant canopy and insecticide sprays (including natural or synthetic soaps, oils, and detergents) may not adequately access these areas. Systemic insecticides may have a select advantage by reducing vector numbers irrespective of developmental stage as all regions of the plant are accessed. Systemic insecticides only work to reduce disease if applied before onset of infection. Neonicotinoids (imidacloprid) and non-neurotoxic insect growth regulators (buprofezin and pyriproxyfen) have been used to control *Bemisia tabaci and* leafhoppers in agronomic and horticultural production systems. However, intensive and unregulated use of insecticides has resulted in insecticide resistance or reduced susceptibility of the vector and may suggest that the efficacy of chemical control may be temporary. Also, frequent insecticide use may disrupt the ecology of other pathogens. Chemical use should be monitored and the manufacturers' instructions or guidelines should be strongly followed.

3. Biological control:
Biopesticides may offer a solution to disease control through introduction of predators and parasitoids of the vector. This measure needs to be monitored by an advisory governing body whose function is to routinely regulate importation and usage, and to provide ecological impact assessments of such production systems. *B. tabaci* is host to the parasitoid, *Encarsia bimaculata* (Mandour et al. 2003). *Encarsia formosa* is among the best studied biological control agents of B. Tabaci.

4. Host resistance: resistance approach is an easy, more effective approach for control of viral diseases. Since 1970s, breeders-:Resistant tomato cultivars through the introgression of resistance genes. Three ToLCV-resistant open-pollinated tomato varieties ('Sankranthi,' 'Nandi' and 'Vybhav') were developed and released officially in 2003-2004 in India."Gene pyramiding"–combining multiple Ty genes in tomatoes with resistance to several whitefly-transmitted begomoviruses that cause TYLCVD (AVRDC, 2009). CLCuV-resistant (RS-875, LRA-5166 and LHH-144) and -tolerant (Om Shankar) varieties. Cassava :TMS 30337, TMS 30395, TMS 30572, TMS 60142, TMS 30001 and TMS 4(2)1425). Maize: SC 403, SC 411, SC 633, SC 635, SC 721 etc.

5. Pathogen derived resistance: The concept of pathogen derived resistance (PDR) was proposed by Sanford and Johnston (1985), who suggested engineering resistance by transforming a susceptible plant with gene sequences derived from pathogen itself. The first manifestation of PDR was provided by the demonstration that transgenic tobacco plants expressing tobacco mosaic virus (TMV) capsid protein (CP) were resistant to infection by TMV. Different strategies for resistance development are:Coat protein mediated, Replication associated protein, Movement protein, Gene silencing, Antisense RNA, Virus-induced cell death and DNA binding proteins.

CONCLUSION:

1. Management geminiviral diseases can be best approached through the use of multiple tactics including interference with viral vector transmission.
2. Molecular markers linked to resistance genes can be instrumental in achieving the pyramiding of resistance genes which will confer resistance to different geminiviruses.
3. PGPR along with chitosan associated with the direct antiviral property against the pathogens, and the elicitation of biochemical defense responses.

4. Rational designed AZFNs which target to the conserved sequence motif of begomoviruses can inhibit the replication of different begomoviruses.
5. Combinatorial approach involving mixtures of transgenes stacked together using conventional breeding within single ‘‘super-resistant’’ plants, can be important means of creating durable resistance to geminiviruses.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Tissue culture: A Rapid plant multiplication technique in Fruit crops

Article id: 22833

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Plant tissue culture, also called micro propagation, is a practice used to propagate plants under sterile conditions or in a controlled environment, often to produce clones of a plant. In these processes, tissues or cells, either as suspensions or as solids is maintained under conditions conducive for their growth and multiplication. These conditions include proper temperature, proper gaseous and liquid environment and proper supply of nutrient. Plant tissue culture relies on the fact that many plant cells have the ability to regenerate a whole plant (totipotency). Tissue culturing, as applied to plants, is presently viewed as an expensive method. Although micro propagation represents one of the few means by which much forestry, plantation and other difficult-to-root species can be clonally reproduced, the high cost of tissue culture techniques has prevented broader application in the marketplace. Consequently, the appearance of clonal forests, fields and crops has not materialized. Micro propagation allows the production of large numbers of plants from small pieces of the stock plant in relatively short periods of time. Once the plant is placed in tissue culture medium, proliferation of lateral buds and adventitious shoots or the differentiation of shoots directly from callus, results in tremendous increases in the number of shoots available for rooting. Rooted "micro cuttings" or "plantlets" of many species have been established in production situations and have been successfully grown on either in containers or in field plantings. The two most important lessons learned from these trials are that this methodology is a means of accelerated asexual propagation and that plants produced by these techniques respond similarly to any own-rooted vegetatively propagated plant. Since plant tissue culture is a very labour intensive process, this would be an important factor in determining which plants would be commercially viable to propagate in a laboratory.

Advantages of micro propagation

Micro propagation offers several distinct advantages not possible with conventional propagation techniques.

i) Rapid multiplication of genetically uniform plants (clones) that possess desirable traits. Single explants can be multiplied into several thousand plants in a very short time. Once established, actively dividing cultures are a continuous source of micro cuttings which can result in plant production under greenhouse conditions without seasonal interruption.

ii) The production of multiples of plants in the absence of seeds or necessary pollinators to produce seeds.

iii) The regeneration of whole plants from plant cells that have been genetically modified. Using methods of micro propagation, the nurseryman can rapidly introduce selected superior clones of ornamental plants in sufficient quantities to have an impact on the landscape plant market.

iv) The production of plants in sterile containers that allows them to be moved with greatly reduced chances of transmitting diseases, pests and pathogens.

v) The production of plants from seeds that otherwise have very low chances of germinating and growing, e.g. Strawberries.

vi) To clean particular plant of viral and other infections and to quickly multiply these plants as cleaned stock for horticulture and agriculture.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Applications of micro propagation

Plant tissue culture is used widely in plant science; it also has a number of commercial applications. These include:

i) Screening cells rather than plants for advantageous characters, e.g. herbicide resistance/tolerance.
ii) Large-scale growth of plant cells in liquid culture inside bioreactors as a source of secondary products, like recombinant proteins used as biopharmaceuticals.
iii) To cross distantly related species by protoplast fusion and regeneration of the novel hybrid.
iv) Embryo rescue (the resulting embryo as a result of cross-pollination which would otherwise normally die is cultured in a medium to rescue it).
v) For production of doubled monoploid plants from haploid cultures to achieve homozygous lines more rapidly in breeding programmes, usually by treatment with colchicine which causes doubling of the chromosome number.
vi) As a tissue for transformation, followed by either short-term testing of genetic constructs or regeneration of transgenic plants.
vi) *In vitro* conservation of germplasm. This technique is mainly used to conserve plant which do not produce seeds or which have recalcitrant seeds which cannot be stored under normal storage conditions in seed gene banks. Hence, vegetatively propagated crops such as root and tubers, ornamentals, medicinal plants and many other tropical fruits have to be conserved using *in vitro* methods.

Various Methods of Micro propagation

Micro propagation of fruit crop can be done through various techniques. Some of these possible techniques include suspension culture, callus culture, meristem culture, shoot tip culture, protoplast culture, embryo culture, anther culture *etc*. Meristem culture is commercially exploited in banana for faster production of virus-free elite planting materials. In citrus, production of true to type, diseases free QPMs can be done using *in vitro* shoot tip grafting (STG) or micro budding. STG along with thermotherapy can be used for elimination virus in the citrus planting materials. Through embryo culture, both the mature and immature embryo can be cultured under *in vitro* condition to obtain a viable plantlet. Embryo rescue technique has emerged as a boon for seedless grape breeding. Anther and ovule culture can lead to haploid plants, followed by subsequent diploidization will form the homozygous fruit plants. Naked plant cells without the cell wall are known as protoplasts. Protoplasm culture and subsequent somatic hybridization opens the avenue for obtaining noble cybrids.

Micro propagation techniques

Micro propagation is a simple concept. The basic protocols were well established by the 1960s and a whole research field and industry grew based on the ubiquitous MS medium (Murashige and Skoog, 1962) and the numerous modifications that have followed. However, in reality, these protocols have been far less than universally successful. Many species and cultivars have not responded to existing protocols. Too often the protocols published by researchers for particular species are not reproducible by other laboratories or do not stand up under sustained production. This is not necessarily the fault of the original researchers, but rather indicates that we have not been taking into account all the critical factors involved in a commercially viable system. This situation has caused some researchers to revisit the basic principles. Modern plant tissue culture is performed under aseptic conditions under filtered air. Living plant materials from the environment are naturally contaminated on their surfaces (and sometimes interiors) with microorganisms, so surface sterilization of starting materials (explants) in chemical solutions (usually alcohol or bleach) is required. Mercuric chloride is seldom used as a plant sterilant today, as it is dangerous to use and is difficult to dispose off. Explants are then usually placed on the surface of a solid culture medium, but are sometimes placed directly into a liquid medium, particularly when cell suspension cultures are desired. Solid and liquid media are generally composed of inorganic salts plus a few organic nutrients, vitamins and plant hormones. Solid media are prepared from liquid media with the addition of a gelling agent, usually purified agar. The composition of the medium, particularly the plant hormones and the nitrogen source (nitrate versus ammonium salts or amino acids) have profound effects on the morphology of the tissues that grow from the initial explant. For example, an excess of auxin will often result in a proliferation of roots, while an excess of Cytokinin may yield shoots.

A balance of both auxin and Cytokinin will often produce an unorganized growth of cells, or callus, but the morphology of the outgrowth will depend on the plant species as well as the medium composition. As cultures grow, pieces are typically sliced off and transferred to new media (subculture) to allow for growth or to alter the morphology of the culture. The skill and experience of the tissue culturist are important in judging which pieces to culture and which to discard. As shoots emerge from a culture, they may be sliced off and rooted with auxin to produce plantlets which, when mature, can be transferred to potting soil for further growth in the greenhouse as normal plants. The procedure for micro propagation consists of 4 stages:

i) Culture initiation
ii) Bud multiplication
iii) Plantlet regeneration and
iv) Acclimatization (Hardening or weaning) in a green house.

Factors affecting The Micro propagation

Several factors affect the micro propagation of fruit trees. All the fruit crops are not equally responsive to the various techniques of micro propagation. Even within a particular fruit crop, the genotype also plays a major role in success of the techniques. Apart from the crop and its genotypes, explants used for inoculation, various methods of surface sterilization, culture medium (its constituents, type, state, strength *etc*.), plant growth regulators, medium pH, phenol exudation, photoperiod and temperature of growing environment *etc*., also affect the response and success of micro propagation in a fruit crop.

CONCLUSION

Plant tissue culture is now a well established technology which has made significant contributions to the propagation and improvement of fruit crops in general. Greater contribution is envisaged from this technology in years to come, both in its own right and as an adjunct to the application of molecular biology. Although micro propagation has several advantages over conventional asexual propagation methods of fruit crops, but till date it is commercially exploited in a limited number of fruit crops. Phenolic exudations, explant browning are some of the major problems in crops like mango and jamun. Therefore, it is necessary to standardize a suitable micro propagation protocol in these crops. However, micro propagation is well established in fruit crops like banana, strawberry, citrus etc. Keeping the advantages of micro propagation under the view, it should be promoted to ensure supply of elite, disease-free, true to type, quality planting materials in fruit crops.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Health Benefits of Vegetables Juice and Detoxification

Article id: 22834

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INTRODUCTION

The healing elements that are found in green vegetables juices are so powerful and synergistic. It is no secret that vegetables are good for you, hence, it stands to reason that vegetable juicing is one of the best things you can do for good health. Vegetables juice provides your body with a very concentrated source of nutrinets and enzymes. Particularly when organic vegetables are used. It also helps to detoxify your body and boost the immune system with high doses of minerals and vitamins that are easy to absorb. So vegetable juicing is an espacially good way to nourish the body especially when you are sick. Some of the best vegetables are lettuce, kale, carrots, parsley, chard and broccoli etc. One of the most important results of giving your cells a healthy dose of vegetable jiuce is that it will help to maintain the pH balance of your body, *i.e.,* alkalinizing ability. Apart from alkalinizing ability, other main benefits of green vegetable juicing include source of plants enzymes, cholophyll, trace minerals, vegetable protien and detoxification abilities.

Detoxification Therapy

Detoxification is the ntural methods of removing or neutralizing toxins by the body through the kidney, liver, feces, exhalation, urine, and perspiration. The industrial revolution has caused the accumulation of toxins in the human body are pesticides, food additives, heavy metals, anesthetics, residue of phramaceutical drugs, legal drugs (alcohal, tobacco, and caffeine) and illegal drugs (heroin, cocaine, and marijuana). Most drinking water contains several chemicals including excessive level of lead. Juicing of vegetables helps to detoxify the body and enables to the cells to absorb and utilized nutrients better. If the cells of body are loaded with toxins, adding more nutrients will be little value, so the ability of fruits and vegetable juicing to detoxify the cells is as important to overall digestion and health as the comsumption of large amount of nutrients and enzymes.

What is Detox Water? Detox water is water that has been infused with the flavors of fresh fruits, vegetables or herbs. It's sometimes referred to as fruit-infused water or fruit-flavored water. You can make detox water at home in lots of different ways, using any combination of fruits, vegetables and herbs that you like. Because it's made by infusing flavor, rather than juicing or blending, detox water contains very few calories. That makes it a popular drink for detox regimens like the "lemon detox" or "master cleanse." Detox water is also often recommended in weight loss plans, especially in place of high-sugar drinks like sugary soda and fruit juice

How to make detox water?

Making detox water at home is very simple. All you need is water and a selection of fruits, vegetables and herbs. Simply chop up your ingredients and add them to hot or cold water, depending on your preference. The more of an ingredient you use, the stronger the flavor will become. If you're making a cold drink, you can leave the detox water in the fridge for 1–12 hours to allow the flavors to infuse more deeply. Be sure to remove the ingredients after this time though, so they don't begin to decompose. If you're in a hurry, crushing or bruising your fruit and herbs before using them can help release the flavors more quickly.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Some popular detox water recipe combinations

Cucumber and mint, lemon and ginger, blackberry and orange, lemon and cayenne pepper, watermelon and mint, grapefruit and rosemary, orange and lemon, lemon and lime, strawberry and basil, apple and cinnamon.

Health claims about detoxification

Detoxification process, juice and water fast together with cleasing diet prevent chronic diseases like ulcer, cardiovascular problems, arthritis, diabetics and obesity. The most important and longest lasting effect of detoxification therapy is the reduction of stress on the immune system. Other benefits include vitality, reduced blood pressure and blood fats (cholesterol and triglyceride), weight loss, toxin removal or detox, balancing the pH of the body, better digestive health, boosting immune function, improving mood, increasing energy levels, improving complexion etc.

Indication of detoxification

Everyone has specific level of tolerance that cannot be exceeded if good health is to be maintained. If the amount of toxins within the body stays below that level, the body can usually adapt and rid itself of these but when the system is overwhelmed.

Some indications that the body may need detoxification are headaches, joint pain, recurrent respiratory problem, back pain, allergy symptoms, insomnia, mood changes and food allergies. Conditions like arthritics, hemorrhoids, sinus, congestion, constipation, ulcers, psoriasis and acne can indicate the need for detoxification. Laboratory test can also be used to check the need for detoxification. The test can involve stool, urine, blood, or liver functions as well as hair analysis.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Effects of natural promoters and quality inhibitors on plant growth

Article id: 22835

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INTRODUCTION:- The term 'hormone' was first used in medicine about 100 years ago for a stimulatory factor, though it has come to mean a transported chemical message. The word in fact comes from the Greek, where its meaning is 'to stimulate' or 'to set in motion'.

Definition:- Hormone as a substance which is transferred from one part of an organism to another (Went and Thimann in 1937). Plant hormones are a group of naturally occurring, organic substances which influence physiological processes at low concentrations. The processes influenced consist mainly of growth, differentiation and development, though other processes, such as stomatal movement, may also be affected. . Plant hormones could be indole compounds (IAA); adenine derivatives (kinetin), derivatives of carotenoids (ABA); terpenes (GA_3) or gases (ethylene). Plant hormones have also called as 'phytohormones'.

Mainly Plant hormones divides in two groups based on their functions.

A) **Plant growth promoters**:- this plant harmones major role in growth promoting activities such as cell division, cell enlargement, tropic growth, flowering, fruiting and seed formation.
e.g., Auxin, Gibberllins and Cytokinins.

B) **Plant growth inhibitor**: - In this categories plant harmones major role in various growth inhibiting activities such as dormancy and abscission e.g., ABA, Ethylene

A) Growth Promoters:-

1)Auxin:- First of the major hormones to be discovered. In 1881, Charles Darwin and his son Francis performed experiments on coleoptiles, the sheaths enclosing young leaves in germinating grass seedlings. IAA is major Auxins. They are generally produced by the growing apices of the stem and roots, from where they mitigate to the regions of their action. Auxins like IAA and IBA have been isolated from plants. NAA and 2,4-D are synthetic auxin. All these auxins have been extensively used in agricultural and horticultural practices.

Effects :-

- Apical Dominance- the growing apical bud inhibits the growth of lateral (axillary) buds in most of the higher plants, a phenomenon called apical dominance.
- Major effect on Cell enlargement and Cell division.
- Vascular tissue differentiation - auxin stimulates differentiation of phloem and xylem.
- Auxin stimulates root initiation
- Tropistic responses - auxin mediates the tropistic (bending) response of shoots and roots to gravity and light.
- Parthenocarpy:-Auxin also induce parthenocarpy. e.g. tomatoes
- Use as herbicides- 2,4-D is widely used to kill the dictoyledonous weeds.
- Leaf senescence - auxin delays leaf senescence.
- Depending on the timing and position of the source auxin may inhibit or promote leaf and fruit abscission.
- Fruit setting and growth - auxin induces these processes in some fruit.
- Fruit ripening - auxin delays ripening.
- In dioecious flowers promotes femaleness (via ethylene)

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

2) Gibberellins :- Gibberellin was first recognized in 1926 by Japanese scientist, Eiichi Kurosova, studying *bakane*, the "foolish seedling" disease in rice. First isolated in 1935 by TeijiroYabuta and Sumuki, from fungal strains (*Gibberellafujikuroi*) provided by Kurosawa. Yabuta named the isolate as "GIBBERELLIN". Gibberellins (GAs) are plant hormones that regulate growth and influence various developmental processes. GAs are usually produced from the methylerythritol phosphate (MEP) pathway in higher plants. The bioactive GAs is GA_1, GA_3, GA_4, and GA_7. They are produced in stem and root apical meristems, seed embryos, and young leaves. Most bioactive GAs is located in actively growing organs on plants.

Effects:

- Stem growth - GA_1 causes hyper elongation of stems by stimulating both cell division and cell elongation. This produces tall, as opposed to dwarf plants.
- GAs causes stem elongation in response to long days.
- GAs used in seed dormancy breaking.
- In dioecious flowers induction of maleness.
- Fruit setting and growth - This can be induced by exogenous applications in some fruit (e.g., grapes).
- Induction of seed germination - GAs can cause seed germination in some seeds that normally require cold (stratification) or light to induce germination.
- Enzyme production during germination - GA stimulates the production of numerous enzymes, notably α-amylase, in germinating cereal grains.
- Delay senescence.

3) Cytokinins:- In plant roots and shoots cytokinins (CK) are a class of plant growth substances that promote cell division or cytokinesis. They are widely distributed in plants, especially in seed. Cytokinin are isolated from immature maize seed. They are produced in the roots and transported throughout the plant via the xylem. They are involved primarily in cell growth and differentiation, but also affect apical dominance, auxiliary bud growth, and leaf senescence.

There are two types of cytokinins:

1. Adenine-type represented by kinetin, zeatin, and BAM.
2. Phenylurea-type like Diphenylurea and Thidiazuron (TDZ).

Derivatives of Cytokinins can be present in glycosylated forms containing ribose, Glucose or both sugars. Amount of cytokinins increases during seed development, particularly while seed tissues are growing and then declines at maturity Cytokinins regulates a range of plant activities including seed germination. They are active in all stages of germination. Also affect the activities of meristemic cells in roots and shoots, as well as leaf senescence. In addition, they are effective in nodule formation. Auxin is known to regulate the biosynthesis of Cytokinins.

Effects :

- Exogenous applications of CKs induce cell division in tissue culture in the presence of auxin
- Cell enlargement and Morphogenesis.
- Growth of lateral buds
- Leaf expansion will occur from cell enlargement.
- Helps in delay of leaf senescence by CKs promote nutrient mobilization.
- CKs may effect in stomatal opening and closing mechanism in some species
- Chloroplast development - the application of CK leads to an accumulation of chlorophyll and promotes the conversion of etioplasts into chloroplasts.

B) Growth Inhibitors

1) Ethylene :-

Ethylene is also an important natural plant hormone, used in agriculture to force the ripening of fruits. It is synthesized in large amounts by tissues undergoing senescence and ripening fruits. It acts at trace levels throughout the life of the plant by stimulating or regulating the ripening of fruit, the opening of flowers and the abscission (or shedding) of leaves.

Effects:

- Effect of ethylene on plants include horizontal growth of seedlings, swelling of axis and apical hook formation in dicot.
- Stimulation of numerous defense responses in response to injury or disease.
- Ethylene used in seed and bud dormancy breaking.
- Fruit ripening harmone.
- Effects on Shoot and root growth and differentiation.
- Adventitious root formation.
- Leaf and fruit abscission.
- Flower induction in some plants.
- Induction of femaleness in dioecious flowers.
- Flower opening.
- Ethylene promotes senescence and abscission of plant organs especially of leaves and flowers.
- Seed germination- enhance seed radicle emergence through the production of ethylene, produced in the radicle.

2) ABA

Abscisic acid (ABA), also called as dormin. ABA functions induce bud dormancy also largely responsible for seed dormancy. ABA can be isolated from immature seeds of many species. Free from of inhibitor can occur at relatively high concentrations especially in legumes. Bound forms like Glucosyl ester and glucoside are also common. ABA major role in seed development, maturation and dormancy. It is also called stress harmone because it stimulates the closure of stomata in the epidermis and increase in tolerance to plants to various kinds of stresses.

Effects:

- Stomatal closure - water shortage brings about an increase in ABA which leads to stomatal closure
- In response to water stress ABA inhibits shoot growth (but has less effect on, or may promote, root growth).
- Storage protein synthesis in seeds induced by ABA
- ABA counteracts the effect of gibberellin on α-amylase synthesis in germinating cereal grains
- ABA affects the induction and maintenance of some aspects of dormancy in seeds. however, appear to be the controlling factor in 'true dormancy' or 'rest,' which is dormancy that needs to be broken by low temperature or light.
- It inhibits precocious germination and viviparity.
- Adversely affects the process of seed germination and promotes seed storage reserve accumulation and desiccation tolerance.
- When seed has highest ABA level, seed accumulates storage compounds that will support seedling growth and germination subsequently.
- Synthesis of storage proteins, lipids and LEA proteins

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

An essay on vegetable seed production

Article id: 22836

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INTRODUCTION

Vegetables occupy an important place in diversification of agriculture and have played a pivotal role in nutritional security. With the changing paradigms of food and nutritional securities, the consumption of vegetables have attained tremendous importance. To meet the ever increasing demand of burgeoning Indian population, production and productivity of vegetables has to be increased manifolds. Due to increasing pressure on land through urbanization and industrialization, it is not feasible to increase the area under vegetables commensurate to our requirements hence the preciousness of high quality vegetable seeds becomes much more significant than it has ever been to increase the yield per unit area. Although use of quality seeds of improved varieties of different vegetable crops has witnessed tremendous growth in vegetable production and productivity, however, the availability of quality seeds in time and at affordable price is still a matter of great concern. Hence, it is imperative to enhance our vegetable seed production. For the pursuit, involvement for seed production at all the levels should be encouraged and for this well-established principles and practices for vegetable seed production are the need of the hour. The availability of quality seed is of utmost importance for increasing the vegetable production. Vegetable growers recognize quality seed of improved varieties as the most strategic resource for higher and better vegetable yields. Seed quality is the possession of seed with required genetic and physical purity that is accompanied with good germinability, health status and minimal moisture content. The growth of plant and the quality of seed production are strongly influenced not only by agronomic or genetic factors but also by the environmental condition, in which production is undertaken.

General principles of vegetable seed production

Production of genetically pure and otherwise good quality pedigree vegetable seed is an exacting task requiring high technical skills and comparatively heavy financial investment. During seed production strict attention must be given to the maintenance of genetic purity and other qualities of seeds in order to exploit the full dividends sought to be obtained by introduction of new superior crop plant varieties. In other words, seed production must be carried out under standardized and well-organized condition. The major aspects to be taken care of during the vegetable seed production are the genetic and agronomic factors, if followed in a right way will end up in successful vegetable seed production.

Genetic principles

These principles highly depend on the genetic characters of seed which can modify its performance in production programme. In seed production genetic characters are evaluated through genetic purity. The important factors causing the deterioration of variety are natural outcrossing, mechanical mixtures and selective influence of disease and thereby reduces chances of obtaining true to type seeds. Other factors which have minor influence include developmental variations, mutations, minor genetic variations and techniques of plant breeder.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Management of genetic purity in vegetable seed production

1. Control of seed source:

Appropriate class of seed purchased from approved source should be used for raising the seed crop. Breeder seed used for raising foundation seed plot and foundation seed used for raising certified seed plot. Seed must be purchased from approved sources like ICAR institutes, State Agril University, Agril. Research Station or State Seed Corporation. (SSC).

2. Land requirement:

There should not be same crop in the previous season to save genetic contamination from volunteer plants. They are unwanted plants of the same crop growing in the seed field from the seeds that remain in the field from previous year crop. These may act as a source of natural outcrossing there by reducing the genetic purity.

3. Isolation distance:

It helps to avoid natural crossing with undesirable plants, as well as to avoid mechanical mixture during sowing and harvesting. The seed crop must be isolated from other nearby fields of the same crop and other contaminating crops as per requirements of certification standards. The isolation of a seed crop can be provided by time, space and barrier between seed fields and contaminating fields. Isolation distances followed in some important vegetable crops are mentioned below in table 1.

Table 1: Recommended isolation distance for foundation & certified seed production of different vegetables.

Vegetable Crops	Minimum isolation distance (meters)	
	Foundation seed	Certified seed
Cowpea	10	5
Garden pea	10	5
Chilli & Capsicum	400	200
Cauliflower, Cabbage and Knol khol	1600	1000
Lettuce	50	25
Carrot	1000	800
Onion	1000	500
Radish and Turnip	1600	1000
Okra	400	200
Tomato	50	25
Brinjal	200	100
Cucurbits	1000	500
Spinach beet (Palak)	1600	1000

4. Field inspection:

Field inspection and approval of growing crops at critical stages for verification of genetic purity, detection of mixtures, volunteer plants, weeds, freedom from noxious weeds and seed borne diseases.

5. Roguing:

Adequate and timely roguing is extremely important in seed production. As mentioned earlier the rogue which differ from normal plant population in being weak or sickly or bolters or dissimilar may cause quick deterioration in seed stocks by cross pollination, transmission of diseases etc. they should therefore be removed at earliest possible date before flowering. It is wise to remove the whole plant and not just the flower head. The number of roguing will vary with the crop, cleanness of planting seed and stage of the

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

multiplication of the seed crop. Roguing in most of the field crops may be done at vegetative/pre-flowering, flowering and maturity stage as per needs of the seed crop.

Agronomic principles

Standardized seed production, besides genetic principles involves the application of the following agronomic principles to preserve good seed quality and abundant seed yields.

1. Selection of suitable agro-climate/ region

Vegetable (variety) grown for seed production in an area must be adapted to the photoperiod and temperature conditions prevailing in that area. Regions of moderate rainfall and humidity are much more suited to seed production than regions of high rainfall and humidity. It may also result in delayed maturity and pregermiantion of seed in many standing crops. Most crops require a dry sunny period and moderate temperatures for flowering and pollination. Excessive dew, rain cause hindrance in normal pollination, too high temperature causes desiccation of pollen and hot dry weather conditions prevail during flowering results in poor seed set.

2. Selection of field

The soil texture, structure and pH should be considered while selecting field for vegetable seed production and soil should be moderately fertile. The seed plot should be free from soil-borne diseases and insect pests, volunteer plants, weed plants and other crop plants. It must have an assured irrigation source. Location should have transportation facility (Rail, road etc.). There should be no forest reserve near to seed plot.

3. Seed rate and spacing

The requirement of seed rate in the vegetable seed production is always less than commercial crop production. Generally large sized seeds are grown in situ. Seed rate is high in direct sown crops compared to transplanted crop. Seed rate depends on season of planting, duration and spread.

Spacing for each crop/variety is fixed based on the spread of plants and by considering easiness for cultural operations like weeding, fertilizer application and harvesting etc.

4. Seed treatment

The seed may require seed treatment before planting, if they are not already appropriately treated. This could be easily done with help of a revolving drum at the farm. While treating the seeds care must be taken to apply the combination of chemicals, bioagents in a correct order viz., fungicide-insecticide-rhizobium. Depending upon the requirement one or more of the following seed treatments may be given:

a. Chemical seed treatment: fungicide/ insecticide
b. Bioagents: *Trichoderma, Pseudomonas*,etc
c. Bioinoculant: *Rhizobium*, PSB, *Azatobacter*, VAM etc.

5. Method of sowing

I. Directed seeding:

Large seeded vegetables like squash and other cucurbits including melons, root vegetables such as carrot and radish, many leafy vegetables, okra and bitter gourd are sown by direct seeding. There are different methods of sowing which needs to be selected based on crop type, irrigation availability. In vegetable seed production, broadcasting should be avoided as it poses difficulty in organizing the cultural operations.

a. Line sowing: Line sowing is essential and has following advantages

1) Seeds are placed at proper & uniform depths
2) Along the rows, interculturing can be done
3) Uniform row to row spacing is maintained

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

4) Seed requirement is less than 'broad casting'

5) Sowing is done at proper moisture level.

b. Ridge planting:

In ridge plant, crops are planted into ridges formed during cultivation of the previous crop. Ridge planting reduces erosion by leaving the soil covered with residue until planting. Gently sloped fields, especially those with poorly drained soils, are well suited to ridge systems. This systems complement furrow irrigation. Eg: root crops- radish, carrot, beetroot, turnip, potato

c. Raised bed planting:

Vegetable crops can be grown on raised-up beds. They are especially advantageous for clayey soils under high rainfall or wherever else drainage is likely to be poor. The vegetables grown on raised bed are solanaceous vegetables, cole crops, onion and garlic.

d. Flat bed sowing:

Flat beds are used where water availability is adequate and there are no drainage problems. In some areas, crops like leafy vegetables, garden pea, beans and potatoes are started out on a flatbed; as the season progresses, soil is thrown into the crop row to mound up the plants; this is called "hilling-up" and is done to control in-row weeds, provide support, and improve drainage. (Potatoes are also hilled up to keep the developing tubers covered with soil.) Hilling-up only works with plants that have enough stem height and leaf clearance to tolerate partial burial. Eg: leafy vegetables, garden pea, beans.

e. Hill channel sowing:

The *'channel and hill' system of cultivation* is most useful and scientific for higher yield. After preparing the field, 45cm wide and 25-30cm deep channels are made preferably from east to west 3.0-4.5m apart and slope on northern side of used for sowing. Eg- cucurbits, dolichus bean etc.

II. Transplanting: Eg- small seeded vegetables like tomato, chilli, capsicum and brinjal are transplanted by raising nursery in open as well as protected conditions.

6. Staking and trailing

Staking is practiced in hybrid seed production of tomato, chilli, capsicum, brinjal for better management of crop and pollination. While trailing is helpful in cucurbits and dolichus bean (pole type) and can be trained with the help of different type of structures.

7. Weed management

Using mulch: The use of plastic mulching is very popular in many vegetable-growing areas. A non-transparent plastic is used to impede the transmission of photosynthetic radiation through the plastic to the weeds so that the development of weeds is then arrested. It should be noted that one application will not be sufficient against perennials.

Use of weedicide: There are two types of weedicides which are applied as a pre-emergence/ post emergence. These are applied for best management of weeds in onion, garlic, leek, cole crops and pepper etc.

a. **Pre-emergence**: Use of Alachlor @ 1.0 kg ha^{-1}, Pendimethalin @ 1.8 kg ha^{-1}, Metribuzin @ 1.0 kg ha^{-1} and Oxidiazon @0.75 kg ha^{-1}.
b. **Post-emergence**: Paraquat and Diquat @ 0.36-1.0 kg ha^{-1}, Metribuzin @ 0.35-1.0 kg ha^{-1}.

8. Irrigation

There are different methods of irrigation like drip, flooding and sprinkler system but mostly followed and suitable is the drip irrigation. Flooding is followed in leafy and solanaceous vegetables. Foliar /sprinkler irrigation should be avoided in vegetable seed production as it leads to flower drop. During flowering period in vegetables like beans, tomatoes, cucurbits etc. it's critical to supply irrigation otherwise leads to defoliation. Another critical period is the development of fruit or seed. For heading crops such as lettuce and cabbage, the most critical period at heading stage. An adequate amount of water is essential for root crops once the root starts enlarging. To protect crop from frost, provide light irrigation.

9. Nutrient management

In the nutrition of seed crops nitrogen, phosphorous potassium and several other elements play an important role for proper development of plants and seeds. It is therefore advisable to know and identify the nutritional requirements of seed crops and apply adequate fertilizers. Adequate fertilization results in maximum yields, god seed quality and better expression of plant type which facilitate roguing and thereby helps in maintaining higher genetic purity as well.

During sowing or preparation of land half of N and full amount of P and K should be applied. Remaining half N should be applied at 35/ 55 days after planting. *Micronutrients* are essential for plant growth, but plants require relatively small amounts of them. They include boron (B), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo) and zinc (Zn). Deficiency of these will lead to problems like pollen sterility, flower drop and stunted growth. During frost and fog conditions potassium or sulphur spray 1-2% would increase the stress tolerance.

10. Crop protection

Successful disease and insect control is another important factor in raising healthy seed crops. Apart from reduction in yield, the quality of seeds from disease and insect damaged plants is invariably poor. Poor disease and insect control affects seed quality by perpetuating in the seed coat or soil which again hits back in next season.Use of imidacloprid 17.8%SL (25g.a.i/ha) and thiomethaxam 25%WG (15g.a.i/ha) are used for control of jassids, thrips and aphid in chilli, okra, tomato and brinjal. Spinosad 45%SC used against diamond back moth in cauliflower/cauliflower and fruit borer in chilli. Need based soil drenching with captan 75 WP @ 0.25 % or captan 75 WS @ 0.2-0.3 % or mancozeb 75 WP @ 0.3 % or metalaxyl + mancozeb @ 0.3 % to manage damping off / rots. Spray mancozeb 75 WP or zineb 75 WP @ 1.5-2 kg / ha in 750-1000 lit water to manage leaf spot and blights.

11. Harvesting and threshing

Proper post-harvest processing is critical to maximize yield, longevity, vigor, and overall quality of the seed crop. At maturity, seed must be harvested, threshed, cleaned, and fully dried before storage. Vegetable crops which have determinate growth habit will be harvested at once, eg: garden pea, spinach beet, methi, broad bean, french bean and cole crops. Indeterminate types will be harvested multiple times periodically. Eg: solanaceous vegetables (tomato, chilli and capsicum), dolichus bean, cow pea (indet.).Vegetable seed crop will be harvested at harvestable maturity (HM). After harvesting 1-2 days of shade ventilation should be given to reduce moisture and after this seeds are subjected to artificial drying. Initial drying will be started from lower temperature of 28 °C and it may reach upto 40 ± 2 °C.

a. Seed extraction

Various types of threshing machines with adjustable cylinder speeds are available for extraction of vegetable seeds. The cylinder clearance, concave mesh size, airflow rate and screen size greatly influence the efficiency of these machines. Every care must be taken to avoid damage to the seed during mechanical threshing, by properly adjusting the speed of the beaters, the width of the gap between the beaters and the concave, the airflow and the sieve sizes.

1. Dry seed separation

Common method mostly performed by women labour. Relatively cheap, easy and make use of surplus local labour. Usually adopted for threshing high value vegetable seeds. Hand threshing may be done in the following ways.

a. Rubbing: Rubbing seeds materials with a pressure in an open-ended trough line with ribbed rubber (bamboo contained). This method is quite suitable for pod materials such as brassicas and radish.

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b. Beating: The seed materials is beaten with the help of wooden pliable sticks repeatedly with a tolerable force as the seeds are separated but not broken.

c. Flailing: Specially designed instruments are used for separating the seeds from the plants.

d. Rolling: Seed materials is rolled on threshing floor or tarpaulin repeatedly and seeds are easily separated.

2. Wet seed separation

1. Manual Method

(a) Maceration e.g., watermelon,
(b) Crushing e.g., brinjal,
(c) Scraping e.g., cucumber
(d) Separated e.g., muskmelon,
(e) Scooping e.g., pumpkins and
(f) Extraction e.g., squashes.

2. Dry Extraction

Dry extraction is done either manually or mechanically. Manual extraction is by beating with pliable bamboo stick or by beating against a hard surface. Threshers (LCT) are used for mechanical extraction. In this method care should be taken to avoid mechanical injury.

3. Wet Extraction

It is normally practiced in fleshy fruits of vegetables like tomato, brinjal, bittergourd, snakegourd and ashgourd. Among these, extraction is easier in brinjal and ashgourd as the fleshy pulp's interference is less. Seeds are separated with pulp and are washed with adequate water and for removing the sliminess; seeds are washed with 0.1% HCl for 2-3 minutes.

4. Fermentation Method

Fruits with pulp and seed are squeezed and kept as such for 24-48 hours. The seeds will settle down. Decayed pulp and immature seed will float. The settled seeds are washed with more of water. The seeds are shade dried and then sun dried before using. Care should be taken to avoid germination of seed during fermentation. The seeds will be dull in color.

5. Chemical method

a. Alkali method

This method is relatively safe and can be used for small quantities of seed in cooler temperate areas where the fermentation method is not used. The pulp containing the extracted tomato seed is mixed with an equal volume of a ten per cent solution of sodium carbonate (washing soda). The mixture is left for up to 48 hours at room temperature and after washed out in a sieve and subsequently dried. This method is not suitable for commercial seed production as sodium carbonate tends to darken the testa of the seed.

b. Acid method

Acid method is often favored by large commercial seed producers as it produces a very bright clean seed. Addition of 30ml of hydrochloric acid per litre of seed and pulp mixture, stirred properly and left for half an hour then the seeds are washed thoroughly with water, sieved and dried.

CONCLUSION:

The above-mentioned practices are of highest importance with respect raising a good seed crop in case of vegetable seed production.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Meadow planting system of guava

Article id: 22837

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INTRODUCTION

The Meadow Orchard is a modem method of fruit cultivation using modified canopy. Better light distribution within tree canopy increases the number of well illuminated leaves. It also promotes rate of photosynthesis that leads to high yield per unit area. This system of guava planting is going to revolutionize the guava industry by enhancing productivity coupled with reduction in production costs. The meadow orchard system of guava accommodates 5000 plants per ha, planted at 2.0 x 1.0 m spacing and managed with regular topping and hedging, especially during initial stages. Topping and hedging in guava are helpful in controlling tree size and extending fruit availability. A comparison between meadow orchard system and the traditional system of fruit growing is necessary to evaluate the potentiality of this technique.

Concept of meadow orcharding

Recently, there is a trend to plant fruit trees at closer spacing leading to high density or meadow orchard. Higher and quality production is achieved from densely planted orchards through judicious canopy management and adoption of suitable tree training systems.

Dwarf rootstock varieties

Pusa srijan, psidium friedrichthalianum, anueploid-82

Comparison between traditional and meadow orchard systems of guava

Attributes	Traditional system	Meadow system
Bearing	After two years	From first year
Production	Average yield is 12-20 t ha-I	Average yield is 40-60 t ha-I
Management	Difficult to manage due to large tree size	Easy to manage due to small tree size
Production cost	Higher cost of production	Lower cost of production
Harvesting	Difficult	Easy

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Quality	Large canopy, poor sunlight penetration and poor quality fruit	Small canopy, better air and sunlight penetration, minimum disease incidence and high quality fruits with good colour development

Establishing Meadow Orchard

Meadow Orchard System is a new concept of guava planting which has been developed for the first time in India at Central Institute for Subtropical Horticulture, Lucknow. The planting is done at 2.0 m (row to row) x 1.0 m (plant to plant), which gives a density of 5000 plants ha-1. Initially, the trees are pruned and trained to allow maximum production of quality fruits during the first year. A single trunk tree with no interfering branches up to 30 - 40 cm from the ground level is desirable to make dwarf tree architecture. After a period of 1-2 months of planting, all the trees are topped at a uniform height of30-40 cm from the ground level for initiation of new growth below the cut ends. No side shoot or branch should remain after topping. This is done to make a single trunk straight up to 40 cm height. After 15-20 days of topping, new shoots emerge. In general, 3-4 shoots are retained from below the cut point after topping. As shoots mature generally after a period of3-4 months, they are reduced by 50 per cent of their total length so that new shoots emerge below the cut point. This is done to attain the desired tree canopy architecture and strong framework. The emerged shoots are allowed to grow for 3 - 4 months before they are again pruned by 50 per cent. After pruning, new shoots emerge on which flowering takes place.

It is emphasized that shoot pruning is done thrice a year. This leads to desired canopy development. Though fruiting starts in the same year, one cannot expect fruits on each and every shoot. Pruning is continued so that plants remain dwarf. After a year, pruning operation is done especially in May-June, September-October and January-February.

Steps in Meadow orcharding of guava

1. Field planting (2×1 m)
2. Top the trees at a height of 30 to 40cm from the ground level after 1 to 2 months of planting
3. New shoot emerge below the cut point
4. Retain 3 to 4 shoot only
5. Prune the shoots after 3-4 months of emergence (cutting back to 50% of their total length)
6. Multiple shoots emerge below cut end

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

7. Further prune the shoots after 3-4 months of emergence (cutting back to 50% of their total length)
8. Shoots initiate and flowering take place
9. Continue shoot pruning (50%) on their ever year
   A. Continue shoot pruning (50%) on their ever year up to 4-5 years to maintain tree shape and size
   B. Back pruning 50% removal of entire portion of plants

Production

The meadow orchard system is more beneficial than any other system. In this system, the production starts in the first year itself giving an average yield of 13 tonnes ha^{-1} which doubles in the next year. In the 3rd and 5th year yield is approximately 40 and 60 tonnes ha^{-1} respectively. This clearly shows that the meadow orchard system is better than other planting systems.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Concept of anhydrobiosis in seeds

Article id: 22838

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INTRODUCTION:

Anhydrobiosis ('life without water') is the remarkable ability of certain organisms to survive almost total dehydration. It requires a coordinated series of events during dehydration that are associated with preventing oxidative damage and maintaining the native structure of macromolecules and membranes. The preferential hydration of macromolecules is essential when there is still bulk water present, but replacement by sugars becomes important upon further drying. Recent advances in our understanding of the mechanism of anhydrobiosis include the downregulation of metabolism, dehydration induced partitioning of amphiphilic compounds into membranes and immobilization of the cytoplasm in a stable multicomponent glassy matrix. Many plant systems can survive dehydration, but to different extents. Desiccation tolerance generally refers to the tolerance of further dehydration, when the hydration shell of molecules is gradually lost. Desiccation tolerance includes also the ability of cells to rehydrate successfully. In nature, anhydrobiosis often bridges periods of adverse conditions.
Living matter has been characterized as depending on two processes:
1) the biosynthesis of the appropriate molecules;
2) their assembly into organized structures.

For cellular organization, the hydrophobic effect is crucial. Hence, water is the driving force for the assembly of phospholipids into biological membranes and, in part, for the conformation of many proteins. If water completely dissipates from living matter, the driving force for cellular organization is lost. Membranes then undergo structural changes and proteins denature. Some organisms nevertheless manage to survive periods of severe desiccation, indicating that mechanisms have evolved in nature that allow the native cellular structures to be maintained in the absence of water. Desiccation tolerance mechanisms are based on the replacement of water by molecules that form hydrogen bonds. It is widespread in the plant kingdom, including: ferns, mosses and their spores; pollen and seeds of higher plants; and, rarely, even whole angiosperm, but not gymnosperm, plants. The phenomenon also occurs in prokaryotes, protists and fungi and animals such as nematodes and crustaceans. Drought and desiccation tolerance are correlated with the presence of considerable quantities of non-reducing di- and oligosaccharides, compatible solutes and specific proteins, such as the late embryogenesis abundant proteins (LEAs) and heat shock proteins (HSPs).

When is desiccation tolerance acquired?

The desiccation tolerance program can be switched on by dehydration and the plant hormone abscisic acid. In anhydrobiotic (orthodox) seeds, this gene expression occurs during development as a part of the maturation program. As a result, seed embryos become desiccation tolerant considerably before maturation drying. Although the water content gradually decreases during the process of seed maturation, this cannot be considered to be dehydration, because the cellular water potential remains constant up to maturation drying. This decrease in water content is caused by a gradual accumulation of dry matter. Signaling to switch on the desiccation tolerance program in developing seeds occurs via abscisic acid, which also inhibits premature germination.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Moderate dehydration - Removal of bulk cytoplasmic water

Upon water loss, the decrease in cellular volume causes crowding of cytoplasmic components and the cell contents become increasingly viscous, increasing the chance for molecular interactions that can cause protein denaturation and membrane fusion. For model membrane and protein systems, a broad range of compounds have been identified that can prevent such adverse molecular interactions, among them proline, glutamate, glycine-betaine, carnitine, mannitol, sorbitol, fructans, polyols, trehalose, sucrose and oligosaccharides. Although they are chemically dissimilar, these compounds are all preferentially excluded from the surface of proteins, thus keeping the proteins preferentially hydrated. In response to cellular dehydration, many plants and microorganisms accumulate compatible solutes, irrespective of whether the dehydration is brought about by drought, freezing or osmotic shock. When the concentration of destabilizing molecules (among them some ions) in cells increases during water loss, counteraction by preferential exclusion is necessary to prevent protein denaturation and membrane fusion. The heat-soluble, hydrophilic LEAs are primarily located in the cytoplasm and nuclei of Cells. Their accumulation to high concentrations coincides with the acquisition of desiccation tolerance and so they are thought to play a primary role in desiccation tolerance. Details about the different classes of LEAs and their assumed functions – among them ion sequestration and replacement of the hydrogen bonding function of water – are available ina few specialized reviews .On the basis of the remarkably high number of polar residues within the structure, some LEAs are thought to coat intracellular macromolecules with a cohesive water layer. This mechanism can be interpreted as a sort of preferential hydration. On further dehydration, LEAs would provide a layer of their own hydroxylated residues to interact with the surface groups of other proteins, acting as replacement water.

Severe dehydration: Removal of water shell

When water dissipates from the water shell of macromolecules at a moisture content of <0.3 (g H2O) (g dry weight) $^{-1}$, the hydrophobic effect responsible for structure and function is lost. It is envisaged that sugars, especially the non-reducing disaccharides but also tri- and tetrasaccharides and fructans that accumulate in anhydrobiotes, can replace the dissipating water – a theory known as the water replacement hypothesis. There is a growing body of evidence that reduction of metabolism, noticeable as a reduction of respiration rate, coincides with survival of desiccation. A coordinated control of energy metabolism at the onset of dehydration or during the acquisition of desiccation tolerance appears to be essential in avoiding oxidative stress conditions and/or accumulation of byproducts of the metabolism to toxic concentrations. When water dissipates from the water shell of macromolecules at a moisture content of <0.3 (g H_2O) (g dry weight) $^{-1}$, the hydrophobic effect responsible for structure and function is lost. It is envisaged that sugars, especially the non-reducing disaccharides but also tri- and tetrasaccharides and fructans that accumulate in anhydrobiotes, can replace the dissipating water – a theory known as the water replacement hypothesis. As the cytoplasm dries to below 0.3 (g H_2O) (g dry weight) $^{-1}$, the molecular mobility in the cytoplasm decreases by more than five orders of magnitude. At 0.1 (g H_2O) (g dry weight) $^{-1}$ (at room temperature), the cytoplasm vitrifies and exists in a so-called glassy state – an amorphous metastable state that resembles a solid, brittle material, but with retention of the disorder and physical properties of a liquid. In a glass state, the rates of molecular diffusion and chemical reactions are greatly reduced. A glass state is characterized by the glass-to-liquid transition temperature, *Tg, which depends on water* content, temperature and its chemical composition.

For example, desiccation-tolerant seeds in which the oligosaccharides have been converted into sucrose by priming are still desiccation tolerant and show no differences in *Tg. In* addition, most desiccation-sensitive seeds lose viability at water contents far above those at which glasses are formed, but nevertheless form glasses when air dried. The crucial function of intracellular glasses might be the provision of stability to macromolecular and structural components during dry storage. Because the viscosity of glasses is extremely high (equivalent to a flow rate of ~0.3 μm yr−1), glasses prevent the crystallization of embedded chemical compounds, fusion between membrane systems and conformational changes in proteins. They considerably reduce the rates of chemical (ageing) reactions. The storage longevity of anhydrobiotic plants is inversely correlated with the molecular mobility in the cytoplasm. This correlation holds even at low water contents [<0.03 (g H_2O) (g dry weight) $^{-1}$], under conditions of which the trend of increasing longevity with further dehydration is Reversed. Thus, the lower the molecular mobility, the greater the life span. Elevated water contents and temperatures increase molecular mobility and consequently decrease life span. For long-term survival, it is therefore important that the cytoplasm of the organism is in the glassy state. Although more research is needed to determine which types of proteins play roles in the glass formation, LEAs are possible candidates. Improved glass stability has been found to coincide with the synthesis of LEA proteins in slowly dried carrot somatic embryos.

CONCLUSION

one sensitive component can be protected in different ways so as to guarantee optimal survival. In the study of plant desiccation tolerance, it has often been found that one specific mechanism does not confer tolerance on its own, but that the interplay of several mechanisms simultaneously is essential. Also, one sensitive component can be protected in different ways so as to guarantee optimal survival. Most biophysical investigations concerning anhydrobiosis in plants have been focused on phenomena in the dried state. Considering that desiccation-sensitive organisms usually die when the water content is still relatively high [e.g. 0.5–2.0 (gH_2O) (g dry weight) $^{-1}$], future research should be aimed at mechanisms of protection that operate in this particular range of water contents. Pressing goals for future research are the understanding of the mechanism of protection by LEAs and HSPs *in vivo,* and how cells cope with membrane destabilization as a result of partitioned amphiphiles.

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Sustainable pulse production through biofertilizer

Article id: 22839

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Biofertilizers are one of the best modern tools for pulse production. It is a gift of our modern agricultural in such a way. Bio-fertilizers are cost effective, eco-friendly and renewable source of plant nutrients which enhances the sustainability of the production system. These are microbial inoculants which enhance crop production through improving the nutrient supplier and their availability. Biofertilizers are applied in the agricultural field as a substitute to our conventional synthetic fertilizers. Bio-fertilizer have vital role towards improving maintaining long term soil fertility and sustainability.

Biofertilizers

'Biofertilizer' is a substance which contains living microorganisms which, when applied to seed, plant surfaces, or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant. Biofertilizers add nutrients through the natural processes of Nitrogen fixation, solubilizing phosphorus, and stimulating plant growth through the synthesis of growth promoting substances. Biofertilizers can be expected to reduce the use of chemical fertilizer and pesticides. The microorganisms in biofertilizers restore the soil's natural nutrient cycle and build soil organic matter. Through the use of biofertilizers, healthy plants can be grown while enhancing the sustainability and the health of soil.

Biofertilizers are eco-friendly organic agro-input and more cost effective than chemical fertilizers. Biofertilizers like *Rhizobium*, *Azotobacter*, *Azospirillum,* Azolla and blue green algae (BGA) are in use since long time ago. *Rhizobium*inoculant is used for leguminous crops. Azotobacter can be used with crops like wheat, maize, mustard, cotton, potato and other vegetable crops. *Azospirillum* inoculants are recommended mainly for sorghum, millets, maize, sugarcane and wheat. Blue green algae belonging to genera Nostoc, Anabaena, Tolypothrix and Aulosira fix atmospheric nitrogen and are used as inoculants for paddy crop grown both under upland and low land conditions (Sabashini*et al*., 2007).

Need for biofertilizer

Biofertilizers are supposed to be a safe alternative to chemical fertilizers to minimize the ecological disturbance. Biofertilizers are cost effective, eco-friendly and when they are required in bulk can be generated at the farm itself. They increase crop yield upto 10-40% and fix nitrogen up to 40-200 kg/ha depending upon the type of pulse crop, microbial strain, climatic and edaphic conditions. The other plus point is that after using 3-4 years continuously there is no need of application of biofertilizers because parental inoculums are sufficient for growth and multiplication. They improve different soil physical, biological and chemical properties in a holistic way. They produce plant growth promoting substances IAA amino acids, vitamins etc. They have 75% moisture and it could be applied to the field directly. Biofertilizers contained 3.5 – 4.0% nitrogen, 2.0 – 2.5% phosphorus and 1.5% potassium. In terms of N: P: K, it was found to be superior to farmyard manure and other type of manure (Mukhopadhyay, 2006).

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Role of biofertilizers

- Makes availability of nutrients.
- Make the root rhizosphere more lively
- Growth Promoting Substances are produced
- More root proliferation
- Better germination
- Improve quality and quantity of produce
- Improve fertilizer use efficiency
- More biotic and abiotic stress tolerance
- Improve soil health
- Residual Effect
- Make the system more sustainable

Types of Biofertilizers: It is two types –

- Nitrogen Fixing Biofertilizers
- Phosphate Soluble Biofertilizers

Rhizobium

Rhizobium belongs to bacterialgroup and do symbiotic nitrogen fixer inhabit in the root nodules of legume crops (Fig 1a). They arethe most efficient biofertilizer as per thequantity of nitrogen fixed concerned. The bacteria infect the legume root and form root nodules within which they reduce molecular nitrogen to ammonia which is utilized by the plant to produce valuable proteins, vitamins and other nitrogen containing compounds. It has been estimated that 40-250 kg N/ha/year is fixed by different legume crops by the microbial activities of *Rhizobium*.

Fig 1. Liquid biofertilizers (a) Rhizobium (b) Phosphorus solubilizing bacteria

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Table 1. Typical biological N fixed by liquid *Rhizobium* in different crops

Host group	Rhizobium species	Crops	Typical N fix (kg/ha)
Pea	*Rhizobium leguminosarum*	Green pea, lentil	62-132
Soybean	*R. japonicum*	Soybean	57-105
Lupini	*R. lupine orinthopus*	Lupines	70- 90
Alfalfa	*R.melliloti*	Melilotus	100-150
Beans	*R. phaseoli*	Phaseoli	80-110
Clover	*R. trifoli*	Trifolium	130
Cowpea	*R. species*	Mungbean, red gram, cowpea, groundnut	57-105
Cicer	*R. species*	Bengal gram	75-117

(**Source:** http://agritech.tnau.ac.in/org_farm/orgfarm_biofertilizertechnology.html)

Azotobacter

It is important and well known free living nitrogen fixing aerobic bacterium.It is used as a biofertilizer for all non-leguminous plants especially rice, cotton,vegetables etc. Of the several species of *Azotobacter*, *A. chroococcum*happens to be the dominant inhabitant in arable soils capable of fixing N^2 (2-15 Mg N_2 fixed/g of carbon) in culture media. The lack of organic matter in the soil is a limiting factor for the proliferation of *Azotobacter* in the soil.

Azospirillum

It belongs to bacteria and fixes the considerable quantity of nitrogen in the range of 20- 40 kg N/ha in the rhizosphere in non-leguminous plants such as cereals, millets,oilseeds, cotton etc. The organism proliferates under both anaerobic and aerobic conditions. It do not form root nodules and live inside plantroots. It stimulates for the production of growth promoting substance (IAA), disease resistance and drought tolerance.

Cyanobacteria

These are free-living as wellas symbiotic *cyanobacteria* (blue green algae)and described by a group of one-celled to many-celled aquatic organisms. These can bebrown, purple or red in colour, found in wet and marshy conditions, only used for ricecultivation and do not survive in acidic conditions.

Azolla

Azolla is a free-floating water fern that floats in water and fixes atmospheric nitrogen in association with nitrogen fixing blue green alga *Anabaena azollae*. *Azolla* is used as biofertilizer for wetland rice and it is known to contribute 40-60 kg N/ha per rice crop.Besides its cultivationas a green manure, *Azolla* has been used as a sustainable feed substitute for livestock especially dairy cattle, poultry, piggery and fish.

Phosphate solubilizing microorganisms (PSM)

The species of *Pseudomonas, Bacillus, Aspergillus* etc. secrete organic acids and lower the pH in their vicinity to bring about dissolution of bound phosphates in soil (Fig 1b).

VAM

A*VesicularArbuscular Mycorrhiza* (VAM fungi) is a type of mycorrhiza in which thefungus penetrates the cortical cells of the roots of a vascular plant.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Role of auxin in seed development

Article id: 22840

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INTRODUCTION

In most flowering plants, the development of a seed starts with the double fertilization and it leads to the formation of two fertilization products: the embryo and the endosperm. The embryo is diploid(1m:1p). Surrounding the embryo is the triploid endosperm(2m:1p). Finally, surrounding the two fertilization products is the seed coat derived from the maternal ovule integuments and receives no direct genomic paternal contribution. This means that a developing seed contains three genetically distinct entities, that have to coordinate efforts in order for the seed to develop. The post-fertilization mechanisms are required to initiate seed formation and bypass the PRC2 block on seed development. Namely, interested in the mechanisms involved in the development of the endosperm and of the seed coat. The endosperm, in particular, is a site for a process called genomic imprinting, or parent-of-origin-specific allele expression. This means that, for some genes, only the maternal allele is expressed, while the paternal one is silenced, and vice-versa. These genes are therefore called maternally-expressed genes (MEGs) or paternally-expressed genes (PEGs). This process is mediated by epigenetic factors, namely DNA methylation and histone modifications, that silence either of the parental alleles. Research implicated the hormone auxin as a major factor involved in initiating seed development. Auxin biosynthesis genes are imprinted in the endosperm, and only expressed from the paternal alleles, while the maternal ones are silenced by FIS-PRC2. After fertilization, auxin is produced in the endosperm and is involved in driving its proliferation. Furthermore, our research also indicates that auxin is exported from the endosperm to the integuments and that this process is mediated by a Type I MADS-box transcription factor called AGL62. In the integuments, auxin leads to the removal of the VRN- and EMF-PRC2s, lifting their repressive block, and allowing the seed coat to form.

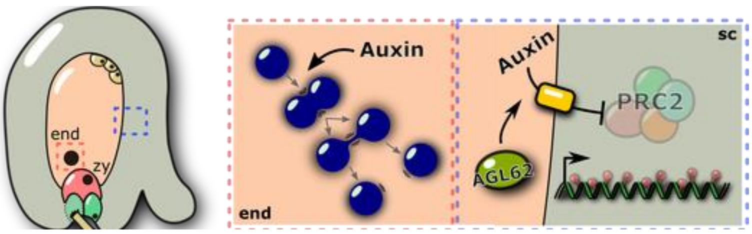

Fig: Auxin lifting repressive block for formation of seed coat

Auxin's roles in pattern formation and organogenesis

The early part of the 21st century has brought new insight into the roles of auxin in establishing developmental patterns and in organogenesis. Pattern formation is the process through which spatial differentiation emerges from a homogeneous material. Pattern formation occurs during plant and animal embryogenesis when the developing organism acquires its axes of polarity: top-to-bottom, in-to-out, and front-to-back. These axes often develop as a consequence of some sort of molecular gradient. In animal development, the term "morphogen" describes a mobile signal that forms a gradient within a developing structure and specifies cell identities and tissue and organ patterning in a concentration-dependent manner. For example, during vertebrate limb development, the "sonic hedgehog" morphogen is secreted from a zone of polarizing activity and specifies the formation of different digits at different positions depending on its concentration. Adding a second source of the morphogen causes a duplicated morphogen gradient and a duplicated, mirror image limb that develops from it. In many of its effect's auxin seems to act as a morphogen (although there are some differences between auxin and animal morphogens, including the fact that auxin does not form a gradient by diffusion but through polar auxin transport). Remarkably, an auxin gradient can be detected in a developing Arabidopsis embryo already after the first cell division. The gradient changes polarity to form a basal maximum at around the 32-cell stage. Formation of this gradient is necessary for proper embryonic root formation. Mutants in which auxin transport is interfered with (pin1,3,4,7) or auxin signalling is disrupted (arf5/mp and iaa12/bdl) are all unable to initiate a root during embryogenesis. Pattern formation in plants also occurs outside of embryogenesis. Cell differentiation regulated by auxin gradient– specified positional information was first shown in the vascular cambium of pine (*Pinus sylvestris*). More recently, an auxin gradient was found to mediate pattern formation in the Arabidopsis female gametophyte. The most thoroughly characterized morphogen-like role of auxin is in the regulation of cell differentiation at the root apex, in which auxin accumulates in a strong and stable gradient with a maximum at the quiescent center. Cells are formed by divisions at the root apical meristem that encompasses the quiescent center. As cells are displaced away from the meristem, they stop dividing, elongate, and differentiate in a position-dependent fashion. Interfering with the auxin gradient through any of several means (mutation of PINs or application of polar auxin transport inhibitors or exogenous auxin to name a few) disrupts the pattern of cellular activities in the root. Auxin has also been described as acting as a developmental trigger, eliciting a specific response at the site of a localized auxin maximum or minimum. A localized auxin maximum is sufficient to initiate the formation of leaves or flowers from the shoot apical meristem or lateral roots from the pericycle cells of the primary root, whereas a localized auxin minimum is necessary for the establishment of the cell separation zone in the Arabidopsis seed pod and also for establishing a competence window for lateral root founder cell specification. It is clear that throughout the life of a plant, from embryo to seed pod, and by acting as a morphogen or a trigger, auxin plays a critical role in conveying positional information.

Arabidopsis embryos follow a regular and stereotypical cell division pattern. Lineages are indicated by thin lines between individual stages. PIN protein localization at membranes is marked with red (PIN1), blue (PIN4), and green (PIN7) lines and DR5 reporter activity is indicated by pink color. (A) After division of the zygote, the one-cell embryo (same for two-cell embryos) expresses PIN7 in the basal daughter cell (bc), with the protein on the side of the apical cell (ac), which expresses the DR5 reporter. After two more cell-division rounds, all proembryo (pe) cells express PIN1 without apparent polarity and show DR5 reporter activity. Basal suspensor (sus) cells express PIN7, which is polarly localized on the proembryo side. At the globular stage, basal PIN1 polarity is established in the central lower cells of the proembryo, whereas PIN1 localizes apically in outer protoderm (pd) cells. At the same time, PIN7 polarity reverses in suspensor cells and PIN4 is activated in the uppermost suspensor cell. This cell now expresses the DR5 reporter and is specified as hypophysis (hyp). During the transition stage, PIN1 polarity at the flanks of apical embryo half converges in adjacent cells accompanied by the appearance of new DR5 maxima. These sites mark the initiation of the cotyledons. (B) At the torpedo stage, primordia for each of the seedling organs can be distinguished. Discrete regions of the embryo give rise to the root apical meristem (RAM, green; note, white cells correspond to the future quiescent center), the hypocotyl (hypo, blue), the cotyledons (cot, yellow), and the shoot apical meristem (SAM, red)

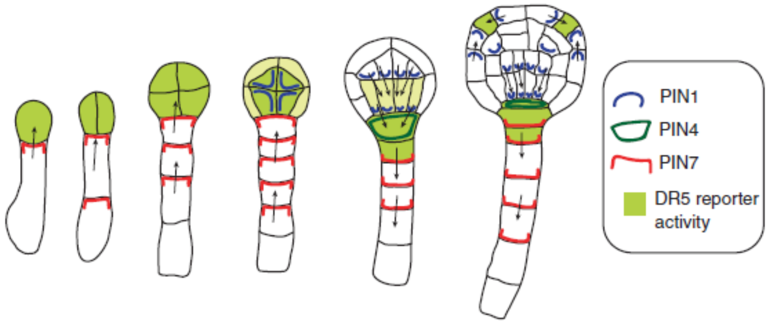

Fig: Auxin efflux and influx carrier proteins in pattern formation

Endosperm development

In many plant species crosses between individuals of different ploidies have long been known to result in abortion of the progeny due to failure of endosperm cellularization, a critical process in seed development. Nevertheless, the molecular mechanisms underlying this developmental transition have remained elusive. The increased production of the plant hormone auxin prevents endosperm cellularization in 3x seeds of Arabidopsis thaliana. Thus, in addition to its known role to initiate endosperm development and seed coat formation (Figueiredo et al., 2015; Figueiredo et al., 2016), auxin levels need to be tightly controlled at later stages of seed development to allow the endosperm to cellularize. The over-production of auxin prevents endosperm cellularization in 2x seeds and that down-regulation of auxin activity in 3x seeds restores cellularization and, consequently, seed viability. Importantly, the auxin-induced endosperm phenotype is characteristic of paternal excess crosses, leading to uncellularized inviable seeds. Auxin biosynthesis genes YUC10 and TAR1 are imprinted and paternally-expressed in the endosperm. Like many other PEGs, YUC10 and TAR1 are upregulated in the endosperm of 3x seeds, likely causing increased auxin biosynthesis. The observed strong increase of ARF expression may be a consequence of a positive feedback loop, similar to the self-sustained activation of the ARF MONOPTEROS during early embryogenesis. ARFs are transcription factors that regulate the expression of auxin-responsive genes and thus are able to amplify the response to increased auxin levels in the endosperm.

The development of the endosperm initiates following the fertilization of the maternal central cell, which points to the requirement of paternal-specific factors for the induction of endosperm proliferation. In fact, sperm entry without karyogamy is sufficient to trigger mitotic divisions of the central cell nucleus; however, sustained endosperm proliferation requires activity of the paternal genome. The endosperm of flowering plants is characterized by the occurrence of genomic imprinting, an epigenetic phenomenon causing parent-of-origin-specific expression of certain genes. Imprinted genes can be preferentially or solely expressed from one of the parental alleles and are thereby termed maternally expressed genes (MEGs) or paternally expressed genes (PEGs). Given that endosperm development requires the activity of the paternal genome, PEGs are the prime candidates promoting endosperm proliferation. Genes coding for the auxin biosynthesis enzymes YUC10 and TAR1 are imprinted in the Arabidopsis endosperm, raising the possibility that auxin could be the factor driving endosperm development. Indeed, application of auxin to unfertilized ovules or ectopic production of auxin in the central cell is sufficient to trigger its replication and initiate endosperm development (Figueiredo et al. 2015).

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

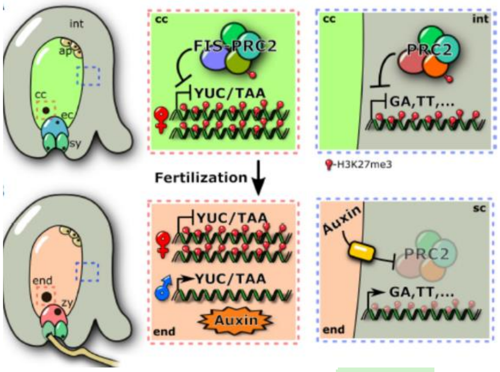

Fig: Endosperm derived auxin in seed development

Seed coat development

Auxin is the missing link connecting fertilization and seed coat development. As the maternal integuments do not take part in the fertilization process, the signal that coordinates the development of the fertilization products with the maternal integuments remained elusive. It seemed likely that the signal is generated in the endosperm, as endosperm development is required to drive seed coat initiation in Arabidopsis. It was furthermore known that the presence of the paternal genome is necessary for the seed coat to develop, as mutants for cdka;1 and fbl17, in which one of the sperm cells fails to undergo karyogamy with the central cell, do not develop a seed coat. These observations strongly suggest that the signal driving seed coat development should be dependent on genes that are paternally-expressed in the endosperm. Auxin biosynthesis following fertilization of the central cell is dependent on the paternally-expressed genes YUC10 and TAR1, raising the hypothesis that auxin could be the trigger for seed coat initiation. These are the points that support the hypothesis (i) auxin rapidly accumulates in the integuments after fertilization, (ii) impaired auxin biosynthesis but not auxin signaling in the endosperm causes defects in seed coat development, (iii) ovules of transgenic lines producing auxin ectopically in the central cell initiate seed coat development without fertilization, (iv) failure of seed coat development in the agl62 mutant correlates with failure to export auxin.

Auxin generated in the fertilized central cell/endosperm is the trigger for seed coat formation. Impaired auxin signaling in the endosperm did not impair seed coat formation, strongly supporting the hypothesis that auxin is exported to the integuments, where it initiates downstream signaling events. We could show that the ABCB transporter PGP10 is expressed in the fertilized central cell and its expression depends on the type I MADS-box transcription factor AGL62, suggests that PGP10 may regulate the export of auxin from the endosperm to the integuments. PGPs are known to depend on additional proteins for their localization and function, likely explains failure to restore seed coat development in agl62 by ectopically expressing PGP10. It is furthermore possible that additional AGL62 targets are required for successful auxin export from the endosperm and are therefore lacking in the agl62 mutant. Future research will focus on identifying the remaining factors required for PGP10 function. Post-fertilization auxin production was shown to lead to activation of GA biosynthesis in the ovules, which is then transported to the valves to promote silique growth. Auxin produced in the central cell is sufficient to drive parthenocarpic growth of the silique couples the fertilization event to fruit development.

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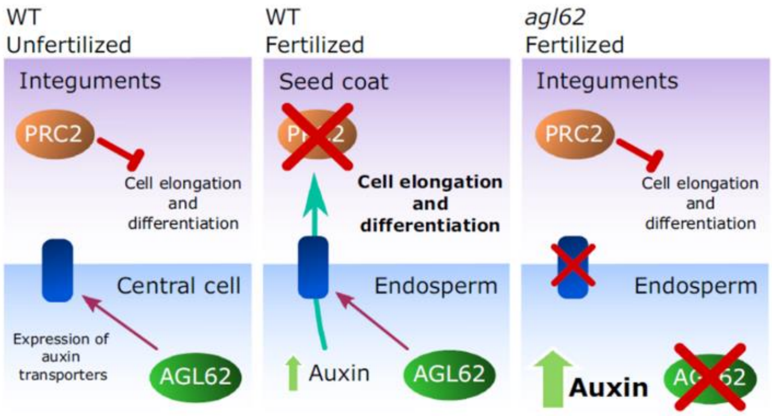

Fig: Model for the post-fertilization mechanism driving seed coat development

Conclusions and future directions

It has long been recognized that auxin is critically and fundamentally important in the life of a plant and that its localized synthesis, transport, and response underlie plant growth and development. It helps to develop the specific pattern formation. Establishes embryo polarity there by defines the root and shoot development. It has immense role in guiding the seed to accomplish the endosperm formation, seed coat development by removing the effects of genetic imprinting.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Auxin synthesis, transport, perception and signalling in plants

Article id: 22841

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INTRODUCTION

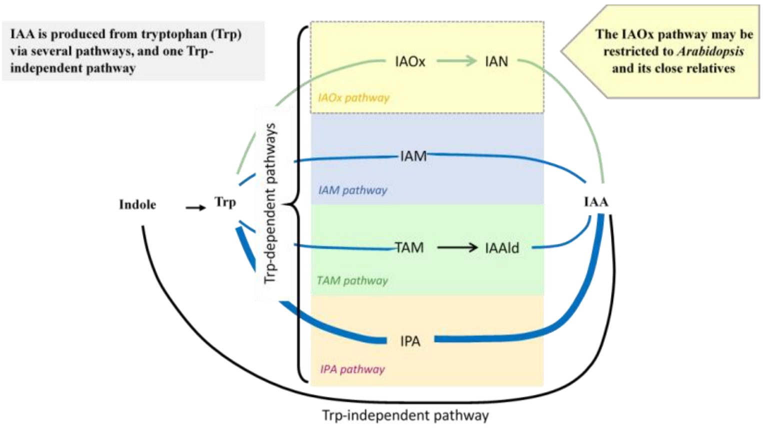
Auxin was the first plant hormone isolated, and it is probably the most thoroughly studied of all plant growth regulators. Many generations of plant scientists have contributed to our understanding of how auxin works. Early botanists carefully described plant growth, development, and movement and even proposed the existence of mobile signals to coordinate these activities. In the late 19th and early 20th centuries, a series of elegant experiments into the nature of shoot phototropism (moving toward light) led directly to the identification of auxin as a mobile signal regulating cell elongation. Most famously, Charles Darwin and his son Francis studied phototropism in coleoptiles, a tissue in monocots that protects young leaves during germination. In 1880, they determined that light given from one side is perceived at the coleoptile tip but that "some influence is transmitted from the upper to the lower part, causing the latter to bend." In 1913, Peter Boysen-Jensen furthered these studies, observing and that the "influence" can move through an agar block but not a solid substance. Subsequently, Arpad Paal (1919) showed that removing the tip of a dark-grown coleoptile and replacing the tip asymmetrically onto the coleoptile base could induce curvature in the absence of a light stimulus. Building upon these studies, Frits Went placed coleoptile tips onto agar blocks and showed that these treated blocks were capable of promoting growth; they had captured the growth-promoting substance. Went's experiments led to the purification and identification of the auxin indole-3-acetic acid (IAA). Auxins in fact are a family of related compounds, some of which are entirely synthetic but mimic auxin effects, whereas others are low-abundance compounds or found in only some plant families. In most discussions, auxin is used synonymously with IAA, which is the most abundant naturally occurring auxin.

Tools in auxin research

Many of our recent insights into auxin action are a consequence of our ability to examine auxin accumulation, action, and transport at the cellular level. The traditional and most precise method for IAA quantification is tissue extraction followed by gas chromatography–mass spectroscopy. Until recently this method was unable to provide cell-specific information, but a refinement has been developed in which cells can be isolated from Arabidopsis roots and sorted based on their expression of cell type–specific green fluorescent protein constructs. Using this method, the auxin concentration of pools of homogenous cell types has been measured by gas chromatography–mass spectroscopy, greatly refining our knowledge of auxin concentrations throughout the root and confirming the presence of a significant auxin maximum at the quiescent center of the root. Auxin-specific antibodies also have been used with varying degrees of success to analyze auxin distribution using immunolocalization methods. Recently-characterized auxin synthesis inhibitors will help explore auxin's roles as well as help define the auxin biosynthetic pathway in different tissues. Auxin responses have been examined using two artificial sensors. The first uses a synthetic auxin responsive promoter called DR5, fused to a reporter gene encoding b-glucuronidase (which cleaves a colorless substrate to produce a blue precipitate) or green fluorescent protein. As this sensor monitors transcription of auxin responsive genes, it is termed an "output sensor". A second sensor, called DII-VENUS, is a constitutively expressed protein consisting of a nuclear-localized yellow fluorescent protein fused to an amino acid sequence that promotes proteolysis in the presence of auxin, the degron domain II of Aux/IAA protein (see below). At high auxin levels, the fluorescent protein is degraded, leading to non-fluorescent regions against a background of fluorescence. Often, the spatial patterns conferred by the DR5 and DII-VENUS reporters are complementary. An important tool for examining patterns of auxin movement (from which some rough approximation of auxin levels can be inferred) comes from the study of auxin transport proteins, described below. Auxin movement through tissues is conferred to a large extent by the polar distribution of auxin influx and efflux proteins. For example, examining localization in neighbouring cells of auxin efflux proteins of the PIN family gives an approximate picture of the direction of local auxin transport within a tissue. Using this method to monitor living tissues over time, very dynamic changes in PIN protein orientation have been revealed, as well as the important roles of auxin and auxin transport during development. Finally, computer models and simulations based on experimental data replicate and predict patterns of auxin accumulation and support the interpretation that auxin has a key role in developmental patterning.

Auxin homeostasis (synthesis, conjugation and catabolism)

Auxin's effects are strongly dependent on its accumulation in the right place at the right time. The combined effects of regulated auxin transport (discussed below) and biosynthesis, conjugation, and degradation see that this happens. At one point it was thought that auxin was exclusively produced in young leaves, but we now know that auxin is synthesized throughout the plant by a set of tightly regulated biosynthetic pathways. Most of the catalytic steps are performed by enzymes encoded by multiple genes, ensuring resiliency, flexibility, and specificity. IAA is mainly produced from the amino acid Trp, although there is evidence for another, Trp independent pathway that is not well characterized. There are several parallel but intersecting pathways for conversion of Trp to IAA, deduced through genetic and biochemical studies. These pathways are often referred to by their key intermediates; the IPA pathway converts Trp to IAA via indole pyruvic acid (IPA), the IAM pathway through indole-3-acetamide, and the IAOx pathway through indole-3-acetaldoximine. The IAOx pathway may be restricted to Arabidopsis and its close relatives. The two-step IPA pathway is thought to account for the majority of auxin biosynthesis in plants. The first step is the conversion of Trp to IPA via the activity of a Trp aminotransferase enzyme, encoded by the TRYPTOPHAN AMINO TRANFERASE OF ARABIDOPSIS1 (TAA1) gene. The second, rate-limiting step is the conversion of IPA to IAA by the YUCCA flavin monooxygenase enzymes. Both gene families are conserved amongst plants. In Arabidopsis, YUCCA is encoded by 11 YUC genes that have different cell type-specific expression patterns. The regulation of the activities of these genes and enzymes is extremely important in regulating auxin accumulation in response to light, temperature, and nutrients. Recently an enzyme that catalyzes the reverse reaction to TAA1 was identified. This enzyme, VAS1, uses the ethylene precursor methionine as a substrate, and so it effectively coordinates auxin and ethylene biosynthesis. This new finding sheds further light on the many ways these two hormones interact, including their synergistic effects on shoot elongation in response to vegetative shading. IAA can be conjugated to other molecules to allow its storage in a biologically inactive form and to trigger its degradation. GH3 genes encode auxin conjugases and are strongly induced by auxin, implying that conjugation is part of a negative feedback mechanism to regulate auxin activity. Similarly, tissues with the highest levels of auxin also accumulate the highest levels of auxin degradation products, suggesting that these tissues have a rapid rate of hormone turnover.



Auxin transport

Many hormones can be translocated through the plant by way of the xylem or phloem, but the directional movement of auxin between cells and tissues is particularly well described, and may be unusual in the extent to which it occurs. Polar auxin transport is fundamental to many of its functions in pattern formation, organogenesis, and directional growth responses. The Cholodny-Went theory proposed in the 1930s postulated that the asymmetries in growth rate in light- or gravity-responding organs are caused by an auxin gradient. After many years, this theory is now widely accepted, largely because of our ability to detect the proposed auxin gradient using the tools described above, and the identification of the chemical and cellular basis by which the auxin gradients are established and maintained. Because IAA is a weak acid, it exists in a charged anionic form (IAA2) in the neutral pH of the cytoplasm (pH ;7). In the more acidic cell wall environment (pH ;5.5), ;15% of the molecules are in the uncharged form (IAAH), which can transit through the plasma membrane. The pH differential between the cytoplasm and wall means that auxin can move into (as IAAH) but not out of plant cells. Changing the pH of the cell wall by overexpression or loss of function of a proton pump protein affects this chemiosmotic movement; when the apoplast is more acidic, a higher proportion of the IAA is uncharged, accelerating auxin transport. Plants also employ specific transport proteins to move auxin precisely. Many auxin transporter proteins were identified through genetic screens for abnormal auxin responses, including agravitropism. The extremely agravitropic aux1 mutant is deficient in polar auxin transport. AUX1 encodes an auxin influx carrier that augments auxin's chemiosmotic influx into cells. AUX1 and its related LIKE-AUX1 genes seem to be particularly important for auxin influx in conditions when auxin efflux rates are high. The ATP Binding Cassette subgroup B (ABCB) transporters comprise a 21-protein family that contributes to auxin transport in diverse ways; some function in auxin influx and some in auxin efflux. (These were previously also known as multiple drug resistance/P-glycoproteins.) Unlike PIN proteins, their cellular position seems to be relatively stable and they may interact with and stabilize PIN proteins at specific microdomains of the membrane. ABCB function is inhibited by plant flavonoid compounds, whose synthesis is increased upon wounding and environmental stresses; thus, these transporters may directly link auxin responses and stress responses.

The PIN genes (named for the pin-formed mutant) encode auxin efflux carriers with asymmetric, polar distributions on cell membranes. Through their polarity, PIN proteins contribute to the highly directional, polar transport of auxin that underlies developmental patterning and differential growth responses. In Arabidopsis, there are eight PIN genes with different tissue-specific expression patterns. Furthermore, the individual PIN proteins themselves can have different cellular distributions within cells. To some extent, these different family members are specialized for specific functions. For example, PIN1 is expressed in the xylem parenchyma throughout the plant and has a major role in the polar transport of auxin from shoot tip to root tip. PIN2 plays a key role in root gravitropism; loss-of-function mutants have

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

a strongly agravitropic phenotype. Localization of the PIN3 protein changes upon a change in light or gravity orientation and is important for establishing the auxin gradients that mediate tropic growth responses, and PIN5 and PIN8 are localized to the endoplasmic reticulum and thought to be involved in intracellular active auxin transport. PIN protein redistribution is critical for the movement of auxin that regulates pattern formation and organogenesis at the shoot apical meristem and during embryogenesis. Auxin maxima are required for and precede the initiation of lateral roots, leaves, and flowers at the shoot apical meristem and the embryonic formation of the radicle (embryonic root) meristem and cotyledons. It remains a fascinating and unresolved question how the PIN proteins themselves are properly positioned, but recent studies suggest that connections between the plasma membrane and cell wall may help maintain their polar distribution. Some PIN proteins undergo continual movement between the plasma membrane and internal endosomal membranes through regulated endo- and exocytosis, which seems to be necessary for PIN repositioning at the cell surface. There are many different routes of intracellular PIN trafficking known. One way is via the molecule clathrin, which forms a polyhedral cage structure that encapsulates membrane vesicles. The PIN phosphorylation state also contributes to this membrane shuttling. PINOID encodes a protein kinase that phosphorylates PIN proteins in vivo. In the pinoid mutant or plants treated with protein kinase inhibitors, PIN proteins can accumulate in internal membranes. By contrast, mutants or inhibitors that interfere with protein phosphatases promote PIN localization to the plasma membrane. Auxin itself regulates PIN protein expression and membrane targeting, in some cases creating a robust and stable pattern of auxin flow (sometimes referred to as canalization). Recently, a further gene family of seven members encoding PIN-LIKES (PILS) proteins was identified and characterized. The PILS proteins do not show extensive sequence similarity to PIN proteins, but they do show a similar protein topology to the PINs, consisting of a central hydrophilic loop flanked at each side by five transmembrane domains. The PILS proteins localize to the endoplasmic reticulum and are thought to regulate auxin homeostasis and intracellular auxin accumulation. Therefore, many different classes of auxin transporters regulate auxin flow within and between cells. The PIN proteins remain the best characterized group and the expression, activity and localization of PIN genes and their encoded proteins are important targets for regulatory inputs from diverse signaling pathways, including light and gravity as well as ethylene and cytokinin. The complexities of polar auxin transport provide us with an engaging and fascinating puzzle and reveal that plants have developed very sophisticated systems to make sure that auxin goes where it needs to go.

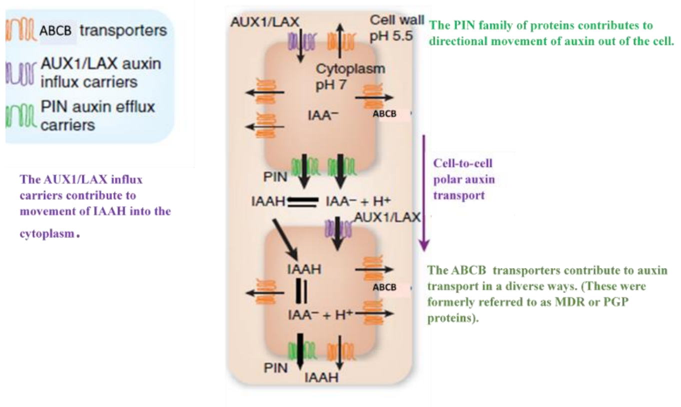

Fig: Auxin efflux and influx transporters

Auxin perception and signalling

Auxin seems to act through multiple types of receptor proteins. AUXIN BINDING PROTEIN1 (ABP1) was identified in the 1970s. Knock-down of ABP1 function has shown that it regulates cell division and expansion during postembryonic growth and is also necessary for the maintenance of the root meristem.

ABP1 is membrane-localized and found in the endoplasmic-reticulum lumen or the outer surface of the plasma membrane. It is associated with auxin responses at the plasma membrane, including the activation of proton pumps and cell wall acidification and loosening. When auxin concentrations are low, ABP1 promotes the clathrin-dependent recycling of PIN proteins. At higher auxin concentrations, this effect is inhibited and so more auxin is transported through the cell-surface PIN proteins, which is a type of positive feedback. ABP1 also contributes to the regulation of the cytoskeleton and cell shape. In 2005, the protein TRANSPORT INHIBITOR RESPONSE1 (TIR1) was identified as an auxin receptor, connecting auxin with the regulated proteolysis of auxin response repressors and continuing a story that had been emerging for more than 25 years. TIR1 is an F-box protein, a component of an SCF (SKP1, CUL1, and F-box protein) ubiquitin ligase complex. Ubiquitin is a small protein that is conjugated to other proteins by ubiquitin ligase complexes, including SCFTIR1. Because the F-box protein confers specificity to this complex by binding to the target proteins, SCF complexes are identified by their specific F-box protein component as indicated. Ubiquitinated proteins are proteolyzed by the 26S proteasome, which selectively degrades proteins, including regulatory proteins. When bound to auxin, TIR1 also specifically binds to Aux/IAA repressor proteins with the auxin holding the proteins together like a molecular glue, targeting them for proteolysis. Genes encoding Aux/IAA proteins were identified in the 1980s and were among the first auxin-induced genes to be identified through the newly developed tools of molecular biology. Aux/IAA proteins are short-lived, nuclear-localized proteins, whose rate of degradation is enhanced by auxin. Aux/IAA proteins have four conserved domains. A short amino acid sequence in domain II was identified as the "degron" and is necessary for auxin induced instability. In the early 1990s, several research groups identified dominant, gain-of-function mutants in Aux/IAA genes; these mutations were mapped to amino acid changes in the degron that interfere with auxin-induced protein degradation. Taken together, these results indicate that auxin signaling is dependent on the degradation of the Aux/IAA repressors and that stabilized mutant proteins confer an auxin-resistant phenotype because they are resistant to degradation. Analysis of the promoters of several auxin-induced genes led to the identification of the auxin response element and a family of proteins that specifically bind to the auxin response element called auxin response factors (ARFs). Arabidopsis has 23 ARF encoding genes. All ARFs have DNA binding domains; some have a transcriptional activation domain and function as transcriptional activators, whereas others function as transcriptional repressors. ARFs and Aux/IAA proteins have homology at their C-terminal domains through which they can form homo- and heterodimers. At low levels of auxin, Aux/IAA proteins can accumulate and, through heterodimerization with ARF proteins, repress auxin responses. When auxin levels increase, SCF-TIR1 binds to auxin and to Aux/IAA proteins, initiating their ubiquitination and proteolysis by the 26S proteasome. Removal of Aux/IAA proteins relieves their repression of ARF protein function. Unrepressed ARF proteins can then exert their effects upon transcription. The way that these two protein families interact has been illuminated by studies of the Arabidopsis embryonic patterning mutants monopteros (arf5/mp) and bodenlos (iaa12/bdl). These mutants have a very similar abnormal phenotype characterized primarily by their inability to form a primary root. The arf5/mp mutant has a loss-of-function mutation in ARF5, which encodes a transcriptional activator. The iaa12/bdl mutant has a gain-of function mutation in IAA12. The increased stability of the IAA12 protein in the iaa12/bdl mutant has a similar effect as loss of the ARF5 transcription factor, highlighting IAA12's role as a repressor of ARF5 function. Overexpression of ARF5 can revert the iaa12/bdl mutant phenotype to the wild type, indicating that the relative abundance of these proteins is important in determining transcriptional outcomes. In some ways, the auxin-mediated signal transduction pathway seems startlingly simple; auxin binds SCFTIR1, which initiates proteolysis of Aux/IAA repressors, derepressing ARF transcription factors. If we contrast this to a canonical signal transduction pathway in which information is relayed from receptor through a series of intermediate proteins to effector proteins,

e-ISSN: 2581 - 8317
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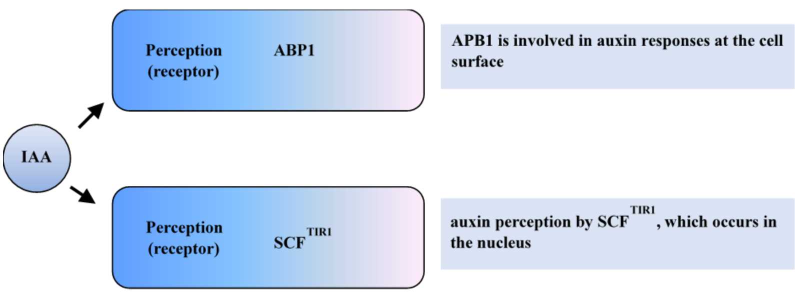
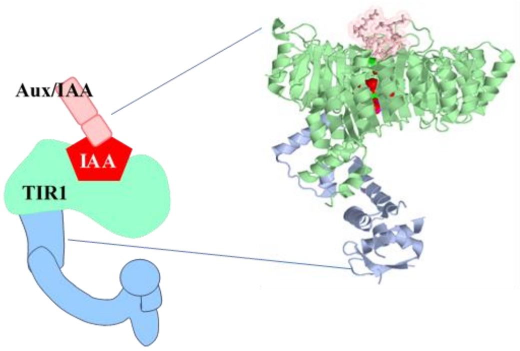
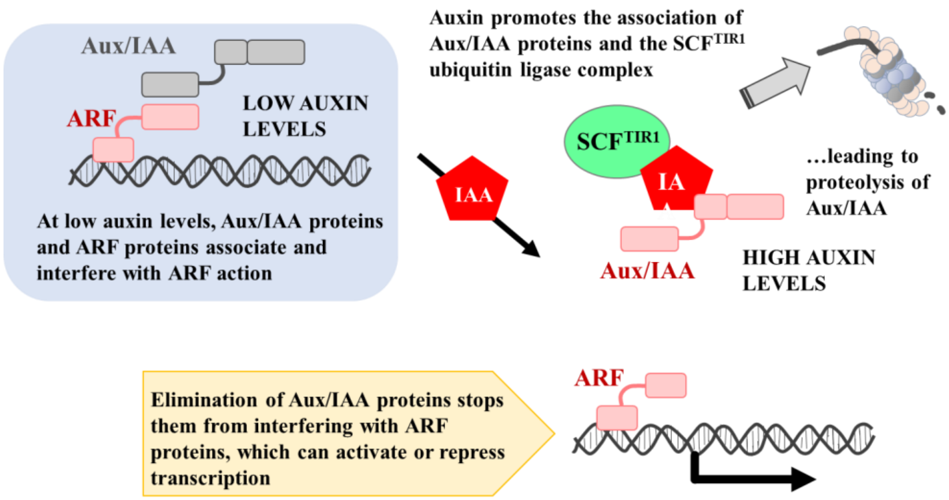
we don't see the same opportunities for amplification or crosstalk that are inherent in longer signalling cascades. However, the Arabidopsis genome encodes 29 Aux/IAA proteins and 23 ARF proteins; it is likely that the complexity and specificity of the auxin response is conferred in part by the combinatorial interactions between these large protein families. Presumably, auxin's effects depend on the relative abundances of each of these proteins, their relative affinities for homo- and heterodimerization, and the binding affinities of the ARF proteins for the promoters of auxin-inducible genes. TIR1 is also a member of a protein family that consists of five additional proteins, AUXIN SIGNALING F-BOX PROTEIN1 (AFB1) through AFB5. As plants have evolved greater developmental and morphological complexity, the proportion of their genome that encodes auxin response genes has increased severalfold, from 0.14% of moss genes to 0.4 to 0.6% of angiosperm genes. Among these, the Aux/IAA genes have been most dramatically amplified, from two genes in moss to 24 to 28 genes in the angiosperms. Although the auxin signalling pathway is short, it nevertheless provides ample opportunity for complexity.



Perception and signalling



SCF^{TIR1} complex



Perception of auxin by SCF^{TIR1} complex

CONCLUSION

It has long been recognized that auxin is critically and fundamentally important in the life of a plant and that its localized synthesis, transport, and response underlie plant growth and development. It helps to develop the specific pattern formation. Establishes embryo polarity there by defines the root and shoot development. It has immense role in guiding the seed to accomplish the endosperm formation, seed coat development by removing the effects of genetic imprinting.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Percolation Pond – The method of artificial recharge of ground water level

Article id: 22842

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Urbanization, industrialization and agriculture continue to compete, environmental requirements are stressed and the quantity and quality of groundwater declines. For countries where there are large variations in the distribution of rainfall, artificial groundwater recharge is essential for sustainable development of water resources. Changing patterns of precipitation along with increased evapotranspiration associated with higher temperatures may affect rates of groundwater recharge. Maintaining groundwater levels will reduce carbon footprint and increase agrarian resistance to hydro-climate change as groundwater during climate vagaries can serve as a buffer source. A depleted aquifer means higher greenhouse gas emissions during times of drought to drain groundwater from deeper layers. The 45 percent of the Tamil Nadu area, groundwater resources are over-exploited and demarcated as black areas.

Artificial recharge is described as the process of replenishing the aquifer by the natural process of infiltration through different methods built according to the conditions of topography, lithology and soil. Artificial recharge is expected to become increasingly necessary in the future as urbanization takes place at a faster pace and the growing population needs more water, which can be supplied by storing water in the underground reservoir in times of surplus. Recharge systems can be used to clean poor quality water because the soil acts as a natural filter. Recharge is also a good option to control the entry of sea water in coastal areas (Singh 2014; Lal & Datta 2018)

Where to Construct?

A percolation pond is a small structure for water collection, installed across a natural stream or waterway to collect and regulate the runoff from the catchments for a longer period of time, to promote the vertical and lateral percolation of impounded water into the soil substrates, thus recharging groundwater storage in the pond's zone of influence.

Infiltration ponds (also called infiltration basins or percolation ponds)

Which are large open water ponds that will usually not exceed 15,000 m^3, whether excavated or surrounded by a bank. They store rainwater, but the main goal is to infiltrate water into aquifers where it can be extracted using boreholes, hand dug wells, or nearby springs. These are installed in places where the pond foundation is permeable and the aquifer to be recharged is situated at or near the surface.

Suitable conditions for construction of percolation pond

The recharging aquifer must be on or near the surface. The pond's base must be permeable. For fine texture soils (e.g. sandy loams), 100 m / year for loamy soils and 300 m / year for coarse clean sands, the typical amount of water entering the ground is 30 m / year. A field method has been developed to determine the rate of penetration in the bottom of dams that can be used to assist in layout. Ideally, the rate of infiltration should exceed the rate of evaporation. Ponds are usually 1-4 m deep, deep enough to prevent the growth of excessive algae or water plants, and shallow enough to prevent the development of anaerobic conditions at the bottom. But the size of the pond should be determined by the catchment

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

area and the amount of potential fillings per year. Similar design strategies to contour trenches could be used for infiltration ponds to efficiently trap runoff in a catchment.

Construction, operations and maintenance

The main issue is to minimize silting, as this will reduce infiltration capacity through the base and sides. There are several techniques to minimize this

- Any systems for drainage and intake should be designed to minimize silt production into the ponds. Before water enters the infiltration pond, sedimentation basins can reduce silt load. What might work better in the run-off region is to maintain a good covering of native grasses. Contour lines in the runoff area also work with trees or grasses. If the channel of inflow is defined, it is possible to try silt traps to reduce silt load. In this case, mini dams and perennial vegetation can be grown between these mini dams to reduce the water flow velocity, thus encouraging silt deposits.
- If the aquifer material is fine, clogging can occur rapidly but may be avoided by covering the base and sides of the pond with a medium sand layer of 0.5 m thick.
- A pond rotation system can allow some to dry while others are used – those that dry up can be scrapped to restore infiltration levels, while the drying process is also good for algae killing. In this case, when scraping is needed, the pond should be shallow enough to allow rapid draining.
- Building ridges on the basin floor and regulating water level can encourage fine silt to be deposited in troughs, allowing most infiltration to occur on the ridge sides.
- Mechanical ploughing of the floor of the basin can also increase permeability.

Costs

Based on water harvesting area, it costs Rs. 2 to 5 lakhs. It can be built with the support of government for the benefit of at least fifty farm families.

Advantages

- Facilitate recharge into the surrounding soil, thereby improving soil moisture, improving agricultural productivity and reducing drought
- Can help replenish shallow wells, boreholes and springs
- Can reduce groundwater salinity

Disadvantages

- Because of lost vegetation cover in the catchment area, they can easily silt up; de-silting takes time and money
- Maintaining dams requires a collective effort and community institutions do not seem strong enough
- High rates of evaporation and construction costs

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Drip Fertigation in Vegetables -A Novel Approach to Increase Productivity and Resource Use Efficiency

Article id: 22843

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Vegetable production is the backbone of Indian agriculture. Apart from nutritional benefits, the production of vegetables improves the economy of a country as these are very good source of income and employment. The contribution of vegetables remains highest (59 – 61%) in horticulture crop productions over the last five years. India is the second largest producer of vegetables in the world with annual production of 184.40 million tones (Horti. Stat., 2018). In Indian agriculture vegetables are important ingredient for nutritional security because vegetables are rich source of nutrients, economically viable, high yield and ability to generate employment. In India 15 agro-climatic zones with distinct seasons which make possible to grow wide array of vegetables. Water and nutrients are key sources for vegetable production. Indiscriminate use of fertilizers and water for irrigation decreases the productivity and use efficiency of fertilizer and water. In climate change scenario it is essential for every farmer to adopt smart agricultural technology to boost the productivity and input efficiency. In this context drip fertigation is a important tool for vegetable production in sustainable manner.

Drip fertigation is a new technology of fertilizer application along with water through drip system. According to FAO field application efficiency of drip irrigation is 90 per cent. In 1993 Yadav and his co-workers concluded that drip irrigation increases the crop yield 25 – 30 per cent and save the irrigation water 50-60 per cent than conventional irrigation method. As well as results of different studies on vegetable crops have shown that drip fertigation results in a saving of 20-25 per cent of the fertilizer. Fertilizer application through drip fertigation allows application of right and uniform amount of fertilizer to the wetted root zone helps to improve quality of produce, nutrient use efficiency and productivity (Jat *et al.*, 2011). Drip fertigation results in efficient use of valuable input such as water and fertilizer. Thus the drip fertigation is an important concept for every horticulturist and vegetable growers.

What is drip fertigation?

Fertigation is a method of fertilizer application along with water. In drip fertigation time of fertilizer application, amount of fertilizer and concentration of fertilizer applied are controlled manually or automatically. Application of fertilizer through fertigation not only reduce the losses of fertilizers but also save the fertilizer due to high fertilizer use efficiency (Kumar and Singh, 2002). Fertigation reduces the wastage of water and chemical fertilizers by improving nutrient and water use by applying them at critical stage and at proper time and place, which finally boost the water and nutrient use efficiency Table 1.

Table 1: Nutrient use efficiency (%) in fertigation

S.No.	Nutrient	Soil application	Drip + soil application	Drip fertigation
1.	N	30-50	65	95
2.	P_2O_5	20	30	45
3.	K_2O	60	60	80

Source- Fertilizer marketing news, 2010

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Fertilizer used in fertigation

In drip fertigation method liquid fertilizer as well as water soluble fertilizers are used. Some commonly used fertilizers given in table 2.

Table 2: Fertilizers used in fertigation

NAME	N, P_2O_5 and K_2O Content	Solubility g/l at 20^0C
Ammonium Nitrate	34-0-0	1830
Ammonium Sulphate	21-0-0	760
Urea	46-0-0	1100
Monoammonium phosphate	12-61-0	282
Diammonium phosphate	18-46-0	575
Potassium chloride	0-0-60	347
Potassium nitrate	13-0-44	316
Potassium sulphate	0-0-50	110
Monopotassium phosphate	0-52-34	230
Phosphoric acid	0-52-0	457

Peculiar features of fertilizers used in fertigation

1. Fertilizers are fully soluble.
2. Quickly dissolved in water.
3. High content of nutrient in saturated solution.
4. These fertilizers do not interact with irrigation water.
5. These fertilizers do not clog filters and emitters.
6. Less insolubility <0.002%.
7. Fine grained and compatible with other fertilizers.
8. Water pH does not change drastically (3.5<pH>9.0)

Impact of drip fertigation on vegetables

Several researchers conducted experiment on importance of drip fertigation in vegetables crops some of the examples are as follows-

- In 2003 Singandhupe and his associates carried out an experiment on tomato and they found that 3.7 – 12.5 per cent higher fruit yield and save 31-37 per cent of water while using drip system rather than surface irrigation. They also reported that application of nitrogen through drip saved 20-40 per cent nitrogen as compared to furrow irrigation.
- Rekha and mahavishnan 2008 reported that use of drip fertigation in vegetable crops saved 40-70 per cent water and 30-50 per cent nutrient.

Methods of Fertigation

1. Continuous application- Application of fertilizers at constant rate from start to the end of the irrigation cycle. The total amount of fertilizers injected regardless of water discharge rate.

2. Three-stage application- In first stage irrigation start without fertilizers. When ground is wet, start injection that is second stage. Before the completion of irrigation cycle stop fertilizer application. In third stage remaining irrigation water allows the fertilizers to be flushed out of the system for system cleansing.

3. Proportional application- The fertilizer rate is proportional to the water discharge rate. For example 1 liter of fertilizer solution is mixed into 1000 liters of irrigation water. This method allows for increased fertigation during the period of high water demond and when most amounts of nutrients are required.
4. Quantitative application- Nutrients are applied in a calculated amount to each irrigation block.

Benefits of drip fertigation

1. Higher nutrient and water use efficiency.
2. Reduces soil and water pollution.
3. Conserve the resources efficiently.
4. Quality products obtained.
5. Higher yield potential.
6. Balanced water and fertilizer application according crop requirement.
7. Enhance availability of nutrients and their uptake by crops.
8. Maintain soil physical properties.
9. Soil and water erosion are prevented.
10. Safe method of application.
11. Efficient weed control.

Constraints of drip fertigation

1. Very costly
2. Clogging of emitters and lines
3. Salt injury to plants.
4. Good quality water is essential.
5. Maintenance of drip system is difficult.
6. Diseases and pest infestation increases.
7. Fertilizer adjustment according to requirement is not a easy task.
8. Availability of water soluble fertilizers are limited.

CONCLUSION

Drip fertigation technology is helpful for farmers to increase their productivity. Drip fertigation helps in efficient utilization of fertilizers, water, saves labour and increases the nutrient and water use efficiency. To achieve maximum results from drip fertigation requires knowledge at various stages during fertigation such as crop nutrient requirement, time and amount of application, irrigation scheduling and soil and crop monitoring techniques etc. Therefore, to make the agriculture sustainable and economically viable and to ensure food and nutritional security of the burgeoning population there is need to promote the fertigation at large scale by the concerned stakeholders.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Nutritional Important and Chemical Composition of Taro *Colocasia esculenta* (L.)

Article Id: 22844

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INTRODUCTION:

Taro (*Colocasia esculent* Linn.) is a vegetative propagated tropical root having its origin from South-east Asia. It occupies 9th position among world food crops with its cultivation spreaded across Africa. Taro tubers are important sources of carbohydrates as an energy source and are used as staple foods in tropical and subtropical countries. It is largely produced for its underground corms contain 70–80% starch. There are numerous root and tuber crops are grown in the world. Taro is one of such crops grown for various purposes. It is an erect herbaceous perennial root crop widely cultivated in tropical and subtropical world belonging to genus Colocasia in the plant family called Araceae. The corm of taro is relatively low in protein (1.5%) and fat (0.2%) and this is similar to many other tuber crops. It is a good source of starch (70–80 g/100 g dry taro), fiber (0.8%), and ash (1.2%). Taro is also a good source of thiamine, riboflavin, iron, phosphorus, and zinc and a very good source of vitamin B6, vitamin C, niacin, potassium, copper, and manganese.

Leaf: The taro leaves rich in protein content (23%) found might be favorably complemented the high carbohydrate contents (87%) found in the tuber part of the plant as a source of human food. The leaves of taro have been reported to be rich in minerals like Ca, P, Fe, and vitamins. The high level of dietary fibre found in the taro leaf are also advantageous for their active role in the regulation intestinal transit, increasing dietary bulk and faces consistency due to their ability to absorb water

Nutritional value of taro: Carbohydrate (expressed as nitrogen free extract, NFE) content reported has been estimated by subtracting the moisture, crude protein, ash, fiber and fat from 100. Zinc and iron content has been analyzed following the AOAC (1990) dry ashing procedure and standard analytical method for atomic absorption spectrophotometry.

Carbohydrate: The high level of carbohydrate content observed in raw taro, taro powder, noodles and cookies agrees with the findings reported by FAO that the main nutrient supplied by taro, as with other roots and tubers, is dietary energy provided by the carbohydrates.

Starch: Taro corm has been reported to have 70–80% (dry weight basis) starch with small Granules. Because of the small sizes (1–4 m in diameter) of its starch granules, taro is highly digestible and as such has been reported to be used for the preparation of infant foods in Hawaii and other Pacific islands. Taro starch is easily digestible, the starch grains are fine and very small, it has hypoallergenic nature and also the starch is gluten free. Taro starch is also good for peptic ulcer patients, patients with pancreatic disease, chronic liver problems and inflammatory bowel disease and gall bladder disease. The most important sugar in taro is sucrose, but fructose, maltose, glucose and raffinose are also present. Malic acid is the most important organic acid (60%) followed by citric acid (25%) and oxalic acid (15%).

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Moisture: Since taro is root crop its moisture content is very high and accounts two third of the total weight of the fresh crops. Moisture content of taro varies with variety, Growth condition and harvest time. In general the moisture content of taro ranges from 60- 83%.

Protein: Taro composes high protein than other root crops because of the presence of symbiotic soil. Bacteria in the root and rhizome part of taro. These bacteria fix atmospheric bacteria and increase nitrogen occurrence in the corm and leaf Moreover the bacteria used as plant growth enhancer due to release of growth hormone to root and distributed to the whole part of the plant. The free-living nature of these soils bacterial also helps the taro crop to grow at different environmental and ecologic conditions. These properties have economic and ecologic important to the environment.

Total Ash: Taro contains fairly high amount of ash. From which it can be inferred it contain good mineral contents. The ash contents of taro ranged from 3.54 - 7.78%.

Health benefits of taro:

Phytochemicals:

Taros have high amount of β-carotene in the corm and will impart vitamin A and antioxidant property in the body. B-carotene differs only very slightly in terms of structure. They are very common carotenoids, and are antioxidants, as well as having other potential health benefits. As mentioned earlier, both can be converted into vitamin A by the body, though β-carotene has about twice the provitamin A activity as α-carotene.

***Phenolic acids*:**

These are simple phenolic acids that are widely distributed in the cell walls of plants and consequently are significant components of the human diet. They have been studied largely in relation to antioxidant activity though these have been largely *in vitro* studies and further work regarding *in vivo* effects in humans is needed before health benefits can be claimed. Yellow-fleshed cultivar of taro is associated with a high level of total phenolic compounds.

Anti–nutritional Factors limiting utilization of taro:

Anti-nutrients which found in taro root have negative implications for taro as a food, yet they also have positive implications for taro as a crop that can be grown with minimal use of fungicides and pesticides. The main anti-nutrients that exist in taro are: mucilage, oxalic acid, tannins, cyanide, lectins, alpha–amylase inhibitors, protease (trypsin and chymotrypsin).

Mucilage:

When raw taro corms are cut in to pieces, the exposed surfaces often exude droplets of a slimy substance called mucilage. The pieces or slices of corm are washed or placed in portable water; a great quantity of mucilage is quickly released or avoided. The crude mucilage is a complex mixture composed mainly of neutral polysaccharides, with small quantities of fiber and protein. Mucilage can be removed by discarding the water used for cooking, or acid ingredients such as lemon juice can be used to neutralize the slimy effect, or the taro can be cooked without water (*e.g.* fried or baked) in a manner that leads to partial dehydration and a dry texture. However, the mucilage in taro corms are important for health because of digestibility and lower blood cholesterol by binding bile, slow blood glucose, slow transit of food through upper GI tract, absorb water and hold moisture that soften stool.

Oxalic acid / oxalates:

Oxalates are one major limiting factor in the utilization of taro is the presence of oxalates which impart acrid taste or cause irritation when raw or unprocessed foods from them are eaten. This acridity is caused by needle–like calcium oxalate crystals, raphides that can penetrate soft skin. Thereafter an irritant

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

present on the raphides, probably a protease can cause discomfort in the tissue. High oxalate concentrations in the leaves and corms of plants consumed daily are of concern because of the harmful health effects associated with the intake of high amounts of oxalates Respectively, Since taro is a staple food it is important to investigate whether the oxalate content of taro leaves poses a risk factor and whether different methods of preparation and cooking can reduce the risk of absorbing excess soluble oxalates when consumed as part of the diet. Wild taro is abundant, particularly in wet lands and is highly resistant to pest and diseases. The wild taro leaf has a high nutritive value, with 22.5-26.3% crude protein.

Lectins:

Plant lectins are an extremely heterogeneous group of proteins that have only one property in common, namely their ability to bind carbohydrates lectins may act as storage proteins that support new growth during the plant lifecycle, and also as biochemical defence molecules that anticipate attack by microorganisms or plant-eating organisms such as nematodes, insects, and other higher animals.

Alpha-amylase inhibitors:

Alpha-amylases are enzymes that help animals and humans to digest starch. The enzymes are found in saliva and the small intestine, and can be inhibited by enzyme-specific inhibitors from many plants. The presence of alpha-amylase inhibitors in taro corms can inactivate human salivary and pancreatic amylases.

CONCLUSION:

Many root and tuber crops are grown throughout the world in hot and humid regions for their use as vegetable as most of them contain starch as the major carbohydrate in them. They are important diet component for human and add variety to it. Taro (*colocasia esculenta*) is one of the staple root and tuber crop grown for various purposes. Taro tubers provide a numbers of desirable nutritional and health benefits such as anticancer activity, phenolic acid and phytochemicals. Taro can be grown as a root crop, as a leafy vegetable, as an ornamental and as medicinal plant. It is a staple crop for many of south-eastern Asia. Taro is an emergent aquatic and semi-aquatic plant. The leaves of taro are consumed as sauces, purees, stews and soups.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Traditional fermented foods and their Health benefits of the North Eastern states of India

Article id: 22845

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North East India is characterized by a diverse population of people with different ethnic background. Most of the people of this region are tribal and bear their own methods of fermenting food materials for the purpose of preservation and taste enhancement and they have been carrying these from time immemorial. All the fermented products are region specific and have their own unique substrates and preparation methods. Materials such as soybeans, bamboo shoots and locally available vegetables are commonly fermented by most of the tribes. Fermentation is the oldest and most economic methods for producing and preserving traditional foods. Some of the important traditional fermented foods of different North Eastern states of India are Ngari, a sun dried fish fermented by traditional ways. Soibum/Soijin, produced from succulent bamboo shoots in Manipur. Hawaijar, a fermented soybean is a traditional food of Manipur. Axone, a fermented soyabean is a traditional food of Sema Naga. Kharoli*, prepared from mustard seeds by the Assamese community. Tungrymbai, a fermented soybean is an indigenous food of Meghalaya. Fermented foods can also have the benefits of enhancing flavor, increased digestibility, improving nutritional value and pharmacological values. Each fermented food is associated with a unique group of microflora which increases the levels of protein, vitamins, essential amino acids and fatty acids.*

INTRODUCTION:

The term fermentation is derived from the Latin word *fervere* meaning “to boil”. It basically describes the appearance of the action of yeast on extracts of fruit or malted grain during the production of alcoholic beverages. It may be defined as any process for the production of a product by the mass culture of microorganism (Stanbury, 1999). Fermentation is one of the oldest and most economic methods of preserving the quality and safety of foods. Fermentation may assist in the destruction or detoxification of certain undesirable compounds which may be present in raw foods. Each fermented food is associated with a unique group of microflora which increases the levels of protein, vitamins, essential amino acids and fatty acids.

North East India is characterized by a diverse population of people with different ethnic background which comprised of the cluster of eight states viz. Assam, Meghalaya, Arunachal Pradesh, Mizoram, Nagaland, Tripura, Manipur and Sikkim. The people of these states have a very rich reserve of traditional knowledge owing to their livelihood in the hilly terrains. These people possess great knowledge of the environment and depend on the forests, plants and plant products for food and other purposes (Jaiswal, 2010). Learning about edible plants and processing and conservation of foods for consumption and medicinal purposes has been in the large part due to incremental and cumulative learning among these societies living in close connection with nature (Singh *et al*., 2007). All the fermented products are region specific varying from place to place and have their own unique substrates and preparation methods. Their flavors and dishes are as unique as their colourful way of life. Most of their dishes use simple and flavourful ingredients like Bamboo Shoots and local greens. Materials such as soybeans, bamboo shoots and locally available vegetables are commonly fermented by most of the tribes. This paper focuses on some of the traditional fermented foods of the North East India and their benefits.

1. *Ziang-sang/ Ziang-dui:*

This is a fermented leafy vegetable product which is common to both the states of Manipur and Nagaland. It is produced dominantly by the *Naga* women and sold in the local markets (Tamang and Tamang, 2009). The microbes associated have been identified as *Lactobacillus plantarum, L. brevis* and*Pediococcus acidilactici* (Tamang *et al*., 2005). *Ziang-sang* is prepared during the winter season.

2. *Goyang:*

The *Sherpa* tribe belonging to the state of Sikkim and hills of Darjeeling prepare this fermented product from leaves of the wild plant *maganesaag* (*Cardamine macrophylla* Willd.) (Tamang and Tamang, 2009). Samples have been found to contain the species *Lactobacillus plantarum, L.brevis, Lactococcus lactis, Enterococcus faecium* and *Pediococcus pentosaceus* (Tamang and Tamang, 2007).

3. *Khalpi:*

Khalpi is a cucumber product of the state of Sikkim and Darjeeling hills. It is generally prepared for home consumption by the *Nepali* Brahmins belonging to the *Bahun* and *Chettri* castes. Microbes associated with its fermentation have been identified as *Lactobacillus plantarum, L. brevis* and *Lecuonostocfallax.*

4. *Anishi:*

Native to the state of Nagaland, this product is prepared mainly by the *Ao* tribe. For its preparation leaves of edible yam (*Colocasia sp.*) are used. It is used as a condiment and is usually cooked with dry meat, especially pork (Mao and Odyuo, 2007).

5. *Soibum/ Soidon:*

These are fermented bamboo shoot products and are indigenous foods of the state of Manipur. They are consumed as an indispensible part of the *Manipuri* diet and are familiar with the social customs of the people. *Soibum* is produced exclusively from succulent bamboo shoots of the species *Dendrocalamus hamiltonii, D. sikkimensis,D. giganteus, Melocana bambusoide, Bambusatulda* and *B. balcona.* The process of fermentation is carried out from the months of June to September when bamboo shoots sprout.

6. *Lung-seij:*

This ethnic fermented bamboo shoot product belongs to the state of Meghalaya and is produced mainly by the *Khasi* women. It is prepared from *Dendrocalamus hamiltonii* species of bamboo available locally in Meghalaya. The protein content of the fermented product has been found to be 8.5 g% which is more than unfermented bamboo shoots.

7. *Mesu:*

Mesu is a fermented bamboo shoot product indigenous to the people of Himalayan regions of Darjeeling hills and Sikkim. It is prepared only during the months of June to September when Bamboo shoots sprout. The species of bamboo used are the locally available *choya bans* (*Dendrocalamus hamiltonii,* Nees and Arnott)*, bhalu bans* (*D. sikkimensis,* Gamble) and *karati bans (Bambusa tulda* Roxb). Its chief producers are the *Limboo* women belonging to *Nepali* community (Tamang and Sarkar, 1996).

8. *Bas-tenga:*

Bas-tenga which means "sour bamboo" is the fermented form of bamboo shoots and produced by the *Nagas* of Nagaland. The fermentation process is carried out during the months of May to June when the new shoots are formed.

9. *Ekung/ Hirring:*

This is an ethnic fermented bamboo shoot product of the state of Arunachal Pradesh. It is called as *ekung* by the *Nyishing* tribe and *hirring* by the *Apatani* tribeof Arunachal Pradesh. It is prepared from mid-April to early September when young bamboo shoots sprout. The species of bamboo used are *Dendrocalamus hamiltonii*, *D. giganteus* Munro, *Bambusa balcooa*, *B. tulda* and *Phyllostachys assamica*

(Tamang and Tamang, 2009). The microbes associated with its fermentation have been found to be *Lactobacillus plantarum, L. lactis, L. brevis, L. casei* and *Tetragenococcus halophilus* (Tamang and Tamang, 2009).

10. Miya mikhri:

It is produced by the *Dimasa* tribe of Assam. For its preparation, the bamboo shoots are collected, cleaned and cut into small pieces. They are then wrapped in banana leaf and kept inside an earthen pot. This pot is then left at room temperature for 4-5 days at room temperature. After the emission of smell, the shoots are shifted to a glass container. This can be stored for about a year. *Miya mikhri* can be taken as a pickle or even mixed with curry (Chakrabarty *et al*., 2009).

11. Ngari:

The fermented fish product *ngari* forms an intrinsic part of the diet of the *Manipuri* people in Manipur. The methods of preservation are traditionally used with cultural identity and these household arts are handed down through generations. The fish species used for its preparation is *Puntius sophore* and they are used in the sun dried form called as *phoubu* (Jeyaram *et al*., 2009). Lactic acid bacteria are the chief fermenting organism found in samples of *ngari.* The species identified are *Lactococcus plantarum* and *Lactobacillus plantarum. Bacillus subtilis, B.pumilus* and *Miocrococcus* sp. have also been isolated from *ngari.* The fungal isolates have been identified as that of *Candida* sp. (Thapa *et al*., 2004).

12. Hawaijar:

Produced in the state of Manipur*, Hawaijar* is a sticky fermented soybean product. Its name is derived from "*hawai"* meaning pulses and "*jar"* which is shortened form of *achar*, meaning pickle (Jeyaram *et al*., 2009). It constitutes an important part of the diet of *Meitei* people since several last decades. The Brahmin community of Manipur is believed to have started the production and consumption of this delicacy.

13. Tungrymbai:

The *Khasi* tribe of Meghalaya prepares *tungrymbai,* which is also a soybean *(Glycine max* (L.) Merril) based fermented food and is very common. It is sticky in nature and serves as a cheap source of protein in the diet of the masses. The bacterial species found to be associated with *tungrymbai* fermentation are *Bacillus subtilis* and *Enterococcus faecium*. The fungal strains have been identified as *Candida parapsilosis, Saccharomyces bayanus, Saccharomycopsis fibuligera* and *Geotrichum candidum* (Sohliya *et al*., 2009; Sarkar *et al*., 1994).

14. Axone / Bekang / Peruyyan:

These are all fermented soybean products and known by different names among different tribes. They are prepared from soybean (*Glycine max* (L.) Merril). Lactic acid bacteria, *Bacillus subtilis* andother *Bacillus* species have been found in these samples. It is known as *axone (aakhone)* in Nagaland, *bekang* in Mizoram and *peruyyan* among the *Apatanis* of Arunachal Pradesh. The fermented product with its characteristic odour can be used in the preparation of chutney along with chilli, tomato and salt. It can also be cooked along with meat to give flavour and taste to the meat.

15. Saphak/ Sathu:

It is a form of fermented pork fat and is called as *saphak* and *sathu* by the *Hrangkol* the *Vaipei* tribes respectively, residing in the north Cachar Hills District of Assam. The *Hrangkol* tribe keep these fats in air tight containers for 10 to 15 days after which they are consumed. The *Vaipei* tribe carryout the fermentation process inside containers made dried gourd cover called as *sathu-um,* by capping the mouth of the container air tight. These are consumed as pickle or as complement with other cuisine (Chakrabarty *et al*., 2009).

16. Kharoli:

This is a kind of fermented mustard (*Brassicajuncea* or *B. nigra*) seeds chutney and is prepared in the state of Assam. The mustard seeds are washed properly. After proper drying they are grinded and sieved. The powder is then placed over the dorsal side of a banana (*Musa* sp.) leaf which heated over the fire in order to soften it. It is a sour favourite among the people of Assam and is eaten as chutney with rice (Hughes *etal*., 2001).

Health Benefits of Fermented Foods:

Microorganisms contributing to the fermentation process have been associated with many health benefits, and so these microorganisms have become another focus of attention. Lactic acid bacteria (LAB) have been some of the most studied microorganisms. During fermentation, these bacteria synthesize vitamins and minerals, produce biologically active peptides with enzymes such as proteinase and peptidase, and remove some non-nutrients. Compounds known as biologically active peptides, which are produced by the bacteria responsible for fermentation are also well known for their health benefits. Among these peptides, conjugated linoleic acids (CLA) have a blood pressure lowering effect, exopolysaccharides exhibit prebiotic properties, bacteriocins show anti-microbial effects, sphingolipids have anti-carcinogenic and anti-microbial properties, and bioactive peptides exhibit anti-oxidant, anti-microbial, opioid antagonist, anti-allergenic, and blood pressure lowering effects (Sanlier *et al.* 2019). As a result, fermented foods provide many health benefits such as anti-oxidant, anti-microbial, anti-fungal, anti-inflammatory, anti-diabetic and anti-atherosclerotic activity. In fact, fermented foods are often more nutritious than their unfermented form.

Here are the key health benefits of fermented foods.

- **Improves Digestive Health:** The probiotics produced during fermentation can help restore the balance of friendly bacteria in your gut and may alleviate some digestive problems. One 6-week study in 274 adults with IBS (irritable bowel syndrome) found that consuming 4.4 ounces (125 grams) of yogurt-like fermented milk daily improved IBS symptoms, including bloating and stool frequency. Fermented foods may also lessen the severity of diarrhea, bloating, gas, and constipation. For these reasons, adding fermented foods to your diet may be useful if you regularly experience gut issues.
- **Boosts Your Immune System:** The bacteria that live in your gut have a significant impact on your immune system. Due to their high probiotic content, fermented foods can give your immune system a boost and reduce your risk of infections like the common cold. Consuming probiotic-rich foods may also help you recover faster when you're sick. Additionally, many fermented foods are rich in vitamin C, iron and zinc, all of which are proven to contribute to a stronger immune system.
- **Makes Food Easier to Digest:** Lactose, the natural sugar in milk is broken down during fermentation into simpler sugars-glucose and galactose. As a result, those with lactose intolerance are generally fine eating fermented dairy like kefir and yogurt. Fermentation helps break down and destroy antinutrients such as phytates and lectins which are compounds found in seeds, nuts, grains, and legumes that interfere with the nutrient absorption. Therefore, consuming fermented beans or legumes like tempeh increases the absorption of beneficial nutrients, making them more nutritious than unfermented alternatives.
- **Mental health:** A few studies have linked the probiotic strains *Lactobacillus helveticus* and *Bifidobacterium longum* to a reduction in symptoms of anxiety and depression. Both probiotics are found in fermented foods.
- **Weight loss:** Some studies have found links between certain probiotic strains including *Lactobacillus rhamnosus* and *Lactobacillus gasseri* and weight loss and decreased belly fat.

- **Heart health:** Fermented foods have been associated with a lower risk of heart disease. Probiotics may also modestly reduce blood pressure and help lower total and "bad" LDL cholesterol.

CONCLUSIONS:

The fermentation technologies practiced by the ethnic people reveal a strong correlation of these people with nature and the assessment of microbial benefits. The rich microbial diversity in various sources of fermented foods and beverages reflects that the indigenous people have been harnessing indigenous micro biota for spontaneous fermentation. Climatic conditions also play major role in the type of fermented foods produced in the temperate, sub-tropical and tropical climates of this region. Besides the food items mentioned here, other products like. Modern science and technological knowledge should be united to produce beneficial results. Development of value added products by selecting productive microbial strains, genetic improvement, process improvement, raw material improvement, improving process control, the use of immobilized systems and/or enzymes, study of probiotic activity and use of genetically modified organisms will lead to industrialization of these food products. Multi-institutional collaborative research will lead to standardization of the fermented food products and increase their shelf life. At present these products are produced only for local consumption. A commercial unit of the traditional fermented foods of the North-Eastern states should be developed which would in turn help in proper marketing of the products in packed form. This would contributes to subsistence of regional economy and prove as a boost to the livelihood of the rural people. Up gradation of the technologies involved can be brought about without damaging the existing form of product. Different kind of neutraceuticals and novel compounds may be produced from fermented foods if proper research is meted out. A database can be developed listing all the fermented foods available in the region, along with their place of origin and production, raw materials used, microorganisms involved, nutritional value and the cost involved. These traditional methods of fermentation and preservation can be commercialized and productivity can be maximised if contributions in terms of financial support and technological development is provided by various governing bodies and institutes.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Methods and importance of milk preservation

Article id: 22846

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Milk is an excellent source of protein. Milk products contain high quality proteins. It is rich in calcium, phosphorus, vitamin A, vitamin B_2, potassium and vitamin D so it is also considered as complete food. It is about 87% water and 13% solids. The fat portion of the milk contains fat soluble vitamins. India has a production of 176.3 million tonnes in 2017-18. Milk is a delicately flavoured, and easily changed food that many preservation methods cannot be used without causing an undesirable change or at best making a different food product. Most of the products from milk are evolved for the purpose of improving the keeping quality.

Preservation of milk

Asepsis: Milk may be preserved by keeping in aseptic condition where the keeping quality is usually improved when smaller numbers of micro organisms are present, especially those which grow readily in milk. Packing also serves to keep microorganisms from bottled milk, fermented milks, packaged butter, canned milk, dry milk and packaged cheese and plastic coatings, wax or other protective substance on finished cheese. Micro organisms can be removed from milk by the process of centrifugation. High speed centrifugation removes about 99% of the microbial spores and more than half the vegetative cells of bacteria plus some proteins. Mould can be removed physically from the surface during curing by scraping or periodic washing.

Use of heat: Heat treatment of milk for preservation to kill all the pathogens that may enter the milk to improve the keeping quality without changing its nutritional value is called pasteurization. The first widely used pasteurisation process for milk involved heating the milk in large tank to 60^0C for atleast 20 minutes. This method has been replaced by the use of plate heat exchangers and a continuous operation involving the high-temperature-short-time (HTST) pasteurization of atleast 72^0C for 15 secs. The HTST is the most widely used commercial pasteurization process today. It usually involves very high temperature (VHT) and ultra high temperature (UHT) systems.

Boiling milk or heating in flowing steam may be used for destruction of all micro organisms except the spores of bacteria but there may be changes in the appearance, palatability, digestibility and nutritive properties of milk. Evaporated milk is canned and then heat processed by steam under pressure with rolling or agitation. Sealed cans of evaporated milk are processed at about 115^0C to 118^0C for 14 to 18min resulting in a commercially sterile product.

Use of low temperature: Most dairy products require the use of low temperatures for preservation except the canning of milk and milk products. For the production of milk of good quality it is essential that it is cooled fast after it is drawn from the cow. Newly pasteurised milk is to be cooled to 7.2^0C or less and maintained there. It is preferable to cool it to temperature well below 7-10^0C. Milk products may be stored in frozen state for eg. Butter in -17 to -18 ^{0}C or lower, concentrated milk at -23 to -24^0C while frozen milk can be concentrated by freeze drying methods.

Drying: Various milk products can be made by removing different amount of water from whole milk. Enough moisture is removed to prevent the growth of micro organisms and increase the concentration of dissolved substances in liquid condensed-milk product in order to inhibit the growth of bacteria. Dry products of milk are skim milk, cream, whey, butter milk, ice cream mix and malted milk. Dry milk is prepared either by roller process or with or without vacuum or by the spray process.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Use of preservatives: The addition of preservatives to diary products is permitted only to a limited extent. The use of sorbic or propionic acid or one of their salt is permitted in cottage cheese, yogurt and some of the hard cheese and processed cheese. The primary objective in adding a preservative to hard cheese or preserved cheese is to prevent the growth of moulds. Cheese is smoked primarily for the addition of flavour, although the drying especially of the rind and the chemical preservatives from the smoke may improve keeping quality.

The addition of hydrogen peroxide combined with a mild heat treatment has been used for pasteurisation of milk for certain kinds of cheese. Most fermented products of milk (yogurt, cheese) are preserved partly by the developed activity produced by the bacterial culture and therefore have a longer shelf life than fluid milk.

Use of irradiation: This method involves treatment of milk with ultraviolet rays but it is not successful in milk preservation because only a thin layer of milk can be successfully irradiated and unless great care is taken, a burnt flavour will result.

CONCLUSION: Since milk is considered as a complete food, it plays an important role for supplying nutrition to the population. Being a perishable item, it needs to be preserved when it is available in abundance in glut season. Different preservation methods for milk are discussed above but most of the methods cannot be implemented by common people. The most common methods for preservation includes fermentation, boiling and low temperature storage while the rest discussed above are practised for commercial purpose in food industries for value addition as well as for long term storage with the generation of employment. Hence processing of milk will help in the development of a community where milk is available in abundance.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Environmental journalism, environmental ethics and environmental policy

Article id: 22847

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Environmental journalism is the collection, verification, production, distribution and exhibition of information regarding current events, trends, issues and people that are associated with the non-human world with which humans necessarily interact. To be an environmental journalist, one must have an understanding of scientific language and practice, knowledge of historical environmental events, the ability to keep abreast of environmental policy decisions and the work of environmental organizations, a general understanding of current environmental concerns, and the ability to communicate all of that information to the public in such a way that it can be easily understood, despite its complexity. Falls within the scope of environmental communication, and its roots can be traced to nature writing. One key controversy in environmental journalism is a continuing disagreement over how to distinguish it from its allied genres and disciplines. The growth of environmental journalism as a profession roughly parallels that Environmental journalism of the environmental movement, which became a mainstream cultural movement with the publication of Rachel Carson's Silent Spring in 1962 and was further legitimized by the passage of the Wilderness Act in 1964. Grassroots environmental organizations made a booming appearance on the political scene in the 1960s and 1970s, raising public awareness of what many considered to be the "environmental crisis", and working to influence environmental policy decisions. The mass media has followed and generated public interest on environmental issues ever since. The field of environmental journalism was further legitimized by the creation of the Society of Environmental Journalists in 1990, whose mission is to advance public understanding of environmental issues by improving the quality, accuracy, and visibility of environmental reporting. Today, academic programs are offered at a number of institutions to train budding journalists in the rigors, complexity and sheer breadth of environmental journalism. Environmental ethics is the part of environmental philosophy which considers extending the traditional boundaries of ethics from solely including humans to including the non-human world. It exerts influence on a large range of disciplines including environmental law, environmental sociology, ecotheology, ecological economics, ecology and environmental geography. Environmental policy refers to the commitment of an organization to the laws, regulations, and other policy mechanisms concerning environmental issues and sustainability. These issues generally include air and water pollution, solid waste management, biodiversity, ecosystem management, maintenance of biodiversity, the protection of natural resources, wildlife and endangered species. Policies concerning energy or regulation of toxic substances including pesticides and many types of industrial waste are part of the topic of environmental policy. This policy can be deliberately taken to direct and oversee human activities and thereby prevent harmful effects on the biophysical environment and natural resources, as well as to make sure that changes in the environment do not have harmful effects on humans. Environmental law is a collective term describing international treaties (conventions), statutes, regulations, and common law or national legislation (where applicable) that operates to regulate the interaction of humanity and the natural environment, toward the purpose of reducing the impacts of human activity. The topic may be divided into two major subjects: pollution control and remediation, and resource conservation, individual exhaustion. The limitations and expenses that such laws may impose on commerce, and the often unquantifiable (non-monetized) benefit of environmental protection, have generated and continue to generate significant controversy. Given the broad scope of environmental law, no fully definitive list of environmental laws is possible. The following discussion and resources give an indication of the breadth of law that falls within the & quote; environmental & quote; metric. Environmental Journalism can be daunting at times, but it is an opportunity to truly make a difference. Above all, a passion for environment and wildlife protection is what provides the motivation to smell out a story and pursue it.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Scenario of Plant Diseases under Climate Change Situation

Article id: 22848

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Climate change is now affecting every country on every continent. The effects of climate change on plant diseases have been the subject of intense debate in the last decade. The change in Global climate is due to increasing concentration of greenhouse gases (GHG) in the atmosphere. The earths' observed climatic changes over the past 50 years are primarily caused by various human activities. Between 1880 and 2015, average global temperature rose by 0.9^{0}C (NASA, 2016). In 2016, the earth experienced its third consecutive hottest year since record keeping began (Nell Greenfieldboyce, 2017). Such changes will not only have a great effect on the growth and cultivation of different crops but also affect the reproduction, spread and severity of many plant pathogens. Elevated temperatures and carbon dioxide concentrations associated with climate change will have a substantial impact on plant-disease interactions. A change in temperature affects both the host and the pathogen. In a similar way elevated moisture, wind and ozone will affect the plant diseases and plant pathogen distribution on different region.

Considering this climate change could profoundly affect the status of agricultural diseases, the focus of this study was to review studies related to the effects of climate change on plant diseases. Taking into account the work done, this review addresses the impact of climate change on plant diseases, considering the effect on crop grown, development and the impact on crop production.

Climate change:

According to an official definition given by UNFCCC (The United Nations Framework Convention on Climate Change) Climate change refers to a change of climate that is attributed directly or indirectly by human activity that alters the composition of the global atmosphere and climate variability observed over comparable time periods. It refers to any change in climate over time, whether due to natural variability or as a result of human activity (IPCC, 2007).

Plant disease and losses due to diseases:

Any malfunctioning of host cells and tissues that result from continuous irritation by a pathogenic agent or environment factor and leads to development of symptoms (Agrios, 2005). The Great Irish Hunger is one striking example of the impact of plant disease. In 1845 more than a quarter million Irish people starved as the result of an epidemic of potato late blight. World-wide losses from diseases range from 9 to 16% in rice, wheat, barley, maize, potato, soybean, cotton and coffee. In USA alone, fungicides worth over US $11.2 billion for control diseases (Agrios, 2005). Plant diseases will respond to climate change, through a number of interactions, take place among host, pathogen, potential vectors.

The classic disease triangle establishes the conditions for disease development, *i.e.* the interaction of a susceptible host, a virulent pathogen and a favorable environment. This relationship is evidenced in the definition of plant disease itself. A plant disease is a dynamic process in which a host and a pathogen intimately related to the environment are mutually influenced, resulting in morphological and physiological changes (Gaumann, 1950). Diseases are responsible for losses of at least 10% of global food production, representing a threat to food security (Strange & Scott, 2005). Agrios (2005) estimated that annual losses by disease cost US$ 220 billion. Besides direct losses, the methods for disease control -

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especially the chemical methods - can result in environmental contamination and in residual chemicals in food, in addition to social and economic problems.

How climate change affect plant diseases?

Effect of Elevated CO_2: an increase in CO_2 levels may encourage the production of plant biomass. Dense canopy favor the incidence of rust, powdery mildew, Alternaria blight, Stemphylium blight and anthracnose disease. Overwintering of the pathogen due to elevated CO_2 can be seen. High disease incidence and severity due to change in host, reproduction of the pathogen has also been reported to increase at high CO_2 level in barley anthracnose (*Colletotrichum gleosporioides*) Hibberd, 2006. Reduced stomatal opening and change in leaf chemistry. In such situation, disease caused by the pathogens that infect through stomata such as *Phyllostica minima* (Phyllostica leaf blight of maple) may be reduced (McElorne *et. al.*, 2005). Effect of elevated concentrations of CO_2 has also been evaluated on two important diseases of rice, namely blast (*Pyricularia oryzae*) and sheath blight (*Rhizoctonia solani*) and rice plants were found more susceptible to injury. In soybean, elevated concentration of CO_2 and O_3 altered the expression of three soybean diseases, namely downy mildew (*Peronospora manshurica*), brown spots (*Septoria glycines*) and sudden death syndrome (*Fusarium virguliforme).* Higher CO_2 can increase the fertility of fungi, which may produce more spores.

Effect of Temperature: When high-temperature stress is developed, plant responses may be similar to those induced by water stress, with symptoms expressed as: Wilting, Leaf burn, Leaf folding, Abscission and Physiological responses. These changes will certainly affect susceptibility to pathogens. Alter the growth stage, development rate and pathogenicity of infectious agent (Chakraborthy *et. al.,*1998). Increase in temperatures with sufficient soil moisture may increase evapotranspiration resulting in humid microclimate in crop and may lead to incidence of foliar diseases favored under these conditions. Increased aggressiveness at high temperatures of stripe rust isolates (*Puccinia striiformis*) Mboup *et. al.*, 2012. Lignification of cell wall increased in forage species at higher temperatures to enhance resistance to fungal pathogens. Higher risk of dry root rot has been reported in fusarium wilt chickpea resistant varieties in those areas when the temperature exceed 33ºc (Dixon *et. al.*, 2012).

Effect of Moisture: Moisture help the activation of fungal, bacterial and nematodes pathogen. Distribution and spread of many pathogens on the same plant and on their spread from one plant to another. In fungal diseases, moisture affects fungal spore formation, longevity and particularly the germination of spores. Late blight of potato, apple scab, downy mildew of grapevine and fire blight are found severe only in the areas with high rainfall or high relative humidity during the growing season. Many other soil pathogen (*Rhizoctonia*, *Phytopthora*), some bacteria (*Erwinia* and *Pseudomonas*) and most nematodes usually cause their most severe symptoms on plant when the soil is wet but not flooded. Excess moisture, favors some dreaded soil borne disease caused by *Phytopthora*, *Phytium*, *R. solani*, *Sclerotium rolfsii* especially in pulses (Sharma *et. al.*, 2010). Drought stress affect the incidence and severity of viruses such as *Maize dwarf mosaic virus* MDMV and *beet yellow virus* BYV (Olsen *et.al.*, 1990).

Effect of Wind: Wind is also more important in disease development. Pathogens such as fungi, bacteria and viruses that are spread either directly by wind or indirectly by insect vectors. Wind also injures plant surfaces due to rubbing action of leaf this facilitates infection by many fungi and bacteria and also by a few mechanically transmitted virus. Sometimes helps prevent infection by accelerating the drying of the wet plant surfaces on which fungal spores or bacteria may have landed. Uredospores and many kind of conidia can be transported by wind for many kilometers. *Erwinia amylovora*, the causal agent of fire blight of apple and pear, produces fine strands of dry bacterial exudates which may be broken off and are transmitted by wind.

Effect of light: Intensity and duration of light may either increase or decrease the susceptibility of plants to infection and also the severity of the disease. Increase the susceptibility of the plants to non obligate parasites, lettuce and tomato plants to *Bortytis* or tomato to *Fusarium*. But decreases their susceptibility to obligate parasite. eg: wheat to the stem rust fungus *Puccinia.* Reduced light intensity generally increases the susceptibility of plant to virus infection. Plant kept in the dark for 1 to 2 days before sap inoculation with a virus produce more local lesion (Agrios. 2005).

Effect of Ozone (O_3) on some fungal plant diseases: Commonly, necrotrophic and biotrophic pathogens show a different behaviour as regards their nutrition. The first obtain nutrients from dead tissues, while the second derive nutrients from living cells and maintain a prolonged and deep interaction with their host. Therefore, all climatic factors that cause or accelerate tissue death (high temperatures or O_3 levels) could favour necrotrophic pathogens. In addition, climatic factors that stimulate plant growth such as elevated levels of CO_2 or increased temperature will change the physiology of the plant, altering host colonization by biotrophic pathogens (Elad and Pertot, 2014). Generally, ozone exposure tends to decrease the incidence of disease caused by obligate parasites, increasing the disease incidence caused by facultative parasites (Manning and Von Tiedemann, 1995).

Adaption Measure for Climate Change: The best economic strategy for farmers to follow is to use integrated disease management practices to closely monitor disease occurrence. Keeping crop management records over time will allow farmers to evaluate the economics and environmental impact of disease control and determine the feasibility of using certain disease management strategies or growing particular crops.

CONCLUSION: Climate change could have positive, negative or no impact on individual plant- patho system. Prediction of disease outbreaks will be more difficult in period of rapidly changing climate and unstable weather. With increasing invasion by non- native pathogens, new epidemic may occur. High incidence of viral disease will be occur due to increases vector population. Due to increased bio mass necrotrophic pathogen will be produce large number of inoculum. These are some limitation that will be there in change of climate.

Looking to the future: Current strategies for management need to modified accordingly. Development and validation of weather based disease forecasting models for Indian condition can serve as an early warning system. Breeding for disease tolerant cultivars need to be initiated. Studies needs to be initiated on changes in host physiology, pathogen life cycle and host pathogen interaction caused by changing climatic parameter.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Recent scenario of Agricultural Research for Tribal and Hill Regions of India

Article id: 22849

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The Indian council of Agricultural research through its institutes located in the North-west Himalayas, North-east Himalayas and Andaman and Nicobar Islands evolved technologies to meet the needs of tribal and hill farmers. These technologies are intended to improve the socio-economic status of target groups, and will help them acquire special skills through vocational training in traditional and non-traditional crops, agroforestry, apiculture, horticulture, animal husbandry, poultry and fisheries.

North-West Himalayas

Varietal development

Vivek Maize Hybrid 39, VL Lahsun 2, VL Mandua 347, VL Tamatar Hybrid 1, VL Shimla Mirch Hybrid1, VL Cherry Tamatar 1, VL Shimla Mirch 3 and VL Tamatar 5 were notified/released for various agroclimatic regions of country.

Development of VL Syahi Hal

Hill farmers generally use the locally available traditional wooden plough. VL Syahi hal was developed as an alternative to the traditional plough. This plough can be used for ploughing as well as levelling fields. The weight was also kept within 11–14 kg to make it convenient for handling. Development of VL Syahi Hal Hill farmers generally use the locally available traditional wooden plough. VL Syahi hal was developed as an alternative to the traditional plough. This plough can be used for ploughing as well as levelling fields. The weight was also kept within 11–14 kg to make it convenient for handling.

NORTH-EAST HIMALAYAS

Soil fertility mapping Geo-referenced soil fertility mapping of macro- and micro-nutrients for the 13 priority districts of Assam state (1 : 50,000 scale) was carried out. These maps can be utilized for optimization of nutrient supply for better crop production and for regularizing supply of nutrients during crop season. Varietal improvement RCM 13, a pre-released short-duration rice culture: RCM 13 line, having a short-duration character, was developed at Manipur centre. The line takes 75 days to reach 50% flowering and matures in about 95–105 days. The genotype was also found suitable as contingent variety for pre- kharif/early kharif/main kharif condition and different cropping systems in the region. It is the first evolved culture having low amylose content (11.7%). Akhanphou rice*:* Akhanphou, a popular local rice cultivar of Manipur, was found highly resistant to leaf blast under uniform blast nursery continuously for two seasons. Besides, the genotype possessed four major blast-resistant genes (*Pita/Pita2, Pi40, Pi54* and *Pi2*), and also showed tolerance to low phosphorus conditions. *Taro:* RCMC 5, a very high-yielding clone of taro (*Colocasia esculenta*) developed at Manipur centre, showed a potential yield of 28.31 tonnes/ha and moderate resistance to *Phytophthora* leaf blight. Identification of candidate genes for aluminium-toxicity tolerance In order to improve aluminium toxicity tolerance in rice, differential expression of six candidate genes under aluminium toxicity stress was studied through semi quantitative PCR. Two candidate genes *IPS1* and *CAX2* were identified for improving aluminium toxicity tolerance. Temperature-tolerant rice and maize and moisture-tolerant tomato for North-eastern hill ecosystem of the 600 rice genotypes tested at Umiam for heat tolerance, RCPL 1-136 genotype appeared most tolerant to high temperature (72% spikelet fertility on recovery) with tolerance for drought (RWC 48.6). Tomato variety Manileima was found suitable under frost condition, whereas Selection 9A has shown resistance to drought and high temperature. Under low light condition, Kashi Hemant performed better than other genotypes. Unique traits of local pigs and poultry Pigs: The performance of pig breeds, Ghoongroo/Duroc was evaluated under low input production system and demonstrated the technology for climate resilient production system. At Umiam, the unique traits of the indigenous pigs of the north-eastern region were identified. Phenotypic and morphometric traits of Brupigs in Mizoram and their performance and the production system were evaluated. Blood samples from Bru pigs and Khasi local pigs were collected, and genomic DNA isolated for microsatellite genetic characterization and DNA repository of indigenous pigs. Andaman And Nicobar Islands Germplasm and crop improvement CARI Brinjal 1, developed by repeated selection and purification cycles from the local collection, survived under wilt pathogen sick condition and gave better yield than other varieties under island conditions. It has been registered with the NBPGR, New Delhi. *Morinda citrifolia*, one of *Eryngium foetidum*, two of *Amaranthus viridis*, seven each of *karanja* and *jatropha*, and 16 of tuber crops were collected and deposited in the NPBGR, New Delhi. Two new indigenous vegetables—*Mukia maderaspatana* and *Limnophila chinensis*—were identified, and 64 species of medicinal and 19 of speciality flowers were collected and maintained in the gene garden of the institute. Indigenous vegetables having rich source of zinc and calcium (*Centella asiatica*), copper (*Sauropus androgynous*), iron (*Portulaca oleracea*) and magnesium (*Amaranthus viridis*), and underutilized fruit *Malpighia glabra* for polyphenol, anthocyanin, carotenoids, tannin and ascorbic acid were identified. *Morinda citrifolia* accession TRA1 was the richest source of polyphenol, flavonoids and ascorbic acid, while TRA2 had higher tannin and anthocyanin. Water and nutrient management in capsicum through drip system Under protected cultivation, application of 50% recommended dose of fertilizers (RDF) as vermicompost + 50% RDF as water-soluble fertilizer through fertigation+ vermiwash spray was found highly profitable and economically viable to get more of yield of Indra variety of capsicum under island ecosystem.

Maize production in *jhum* condition:

ICAR Research Complex for NEH Region, Umiam, Meghalaya in a participatory production technology development to identify efficient varieties and improved agronomic management practices (IAMP) for maize production in *jhum* condition, evaluated nine varieties (Hemant, Vijay Composite, DA 61A, RCM 1-1, RCM 1-3, RCM 75 and RCM 76, SaruTangring, SaruBhoi) and compared with farmers' practice at *jhum* field of Sonidan Village of Meghalaya.

Ramie cultivation in Garo Hills:

Under *Jhum* improvement programme Ramie (*Boehmeria nivea*) crop was introduced in Garo Hills. Ramie was planted in collaboration with DAO, West Garo Hills in 8 ha area benefitting 57 farmers. Three Ramie Growers Associations were formed. Seeing the growth of the plants and interest of beneficiaries, Meghalaya Government initiated 'Ramie Mission' with an outlay of ` 40 crore targeting 2,000 ha area.

Value-addition

Four different new generation value-added products were developed from Manipuri black cherry (*Prunus nepalensis*), passion fruit and pineapple. Passion fruit juice was converted to a semi-solid gel and shaped into small balls using silicon mould. In pineapple, the juice was converted to soft gel and the product can be used as sweet or soft candy. All the products can be served instantly, kept in a refrigerator or packed in food grade polyethylene pouch.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

First record of shovel nosed lobster, *Thenus unimaculatus* from Andaman and Nicobar Islands:

30 species of lobsters belonging to 5 families occurring in India, 11 species belonging to three families (Palinuridae, Scyllaridae and Nephropidae) were reported from Andaman and Nicobar Islands. Shovel nosed lobsters are one of the components in multiday demersal trawlers operating in Andaman and Nicobar Islands. The only species of shovel nosed lobster belonging to family Scyllaridae reported from the islands till date is *Thenus orientalis* (Shanmughan and Kathirvel 1983). Fisheries Division of ICAR-CIARI submitted 5 nucleotide sequences of *Thenus unimaculatus* from Andaman and Nicobar Islands in NCBI GenBank, USA and accession numbers (KT362350, KT362351, KT362352, KT362353, KT362354) were provided by NCBI GenBank, USA.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Bacterial diseases of fish

Article id: 22850

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INTRODUCTION

Disease issues are of great concern in aquaculture production. Among diseases Bacterial infections are considered the major cause of mortality in aquaculture. Most of the causative microorganisms are essentially opportunist pathogens which invade the tissues of a fish host rendered susceptible to infection by stress factors or other disease processes. The most significant group of microorganisms comes under both gram-negative bacterial groups which plays a significant role. The actual role of bacteria in pond may vary from that of a primary pathogen to that of opportunist invader of a host rendered moribund by some other disease processes. Even though the diseases caused by these primary pathogens, all are almost invariably stress - mediated. Usually it is only after some major change in the physiology of the fish, due to the action of an external stressor, or occasionally associated with an internally driven change such as spawning, that overt clinical disease is manifested. Waters with a high organic load, which favour the multiplication of bacteria, rapidly changing temperatures, overcrowding, trauma and transportation are the most commonly encountered environmental stress factors which predispose to clinical disease in fish. Such factors are particularly likely to arise in intensive fish culture systems.

Study of the bacterial diseases of fish is rendered difficult by the current lack of adequate understanding of the interactions taking place between bacteria, their hosts and the aquatic ecosystem in general. Representatives of some 92 bacterial genera have been implicated as pathogens of fresh - water and/or marine fish.

Bacterial diseases of finfish

1. Columnaris

It is caused by *Flavobacterium columnare* designated by Bernardt *et al.,* (1996). Other names include *mxyobacterial disease, peduncle disease, saddleback, fin rot, cotton wool disease,* and *black patch necrosis.* The organism is usually associated with the mucus of both normal and diseased fish.

Morphology: It's a gram - negative, slender flexible rods of size 0.5 × 4 – 12 µ m. They appear as dome-shaped columns in wet mount preparations resembling fruiting bodies.

Symptoms: The condition has also been described as 'saddleback' disease due to the development of areas of grey discolouration around the base of the dorsal fin. It is primarily an epithelial disease, i.e., it causes erosions and necrosis of the skin and gills which may become systemic. It often presents as whitish plaques that may have a red peripheral zone on the head or back (hence the name *saddleback*) and/or the fins (hence, *fin rot)* and especially the caudal fin (hence, *peduncle disease).* Fragments of the fin rays may have a ragged appearance. Lesions rapidly progress to ulcers. Ulcerations penetrate into deeper tissues, producing a septicemia.

Treatment: Antibiotic treatment is very difficult as affected fish rarely feed and the stress of capture for parenteral treatment is usually counter - effective.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

2. Edwardsiellosis

A pathogen of warm –water fishes, particularly catfish and eels, first isolated in Japan and named as *Edwardsiella tarda* by Wakabayashi and Egusa (1973). There are two motility phenotypes. Typical strains exhibiting motility are isolated mainly from fresh- water fish and Japanese flounder.

Morphology: It's a small, straight, motile Gram - negative rods (1.0 × 2.0 – 3.0 µm).

Symptoms: Clinically, lesions are initially observed as 3 to 5 mm red cutaneous foci on the flanks and caudal peduncle. They are caused from fistulas originating deep in the skeletal muscle. There is petechiation and malodorous liquefactive necrosis of the viscera with fibrinous peritonitis. Catfish affected with this disease will continue to eat even if they are severely affected. Definitive diagnosis is based on identification of the bacterium within the lesions and the attendent clinical findings. A fluorescent antibody test is available for identification of the bacterial agent, using kidney as the target tissue.

Treatment: Sulphonamide or tetracycline treatment will assist in reducing losses but improvement in hygiene, water quality and stocking density are also necessary.

3. Yersiniosis

The name RM (redmouth) disease is caused by the pathogen *Yersinia ruckeri*.This disease is also known by the following synonyms: *Enteric Redmouth Disease, Redmouth,* and *Blood Spot Disease.* This disease is caused by the pathogen *Yersinia ruckeri*. This is an important pathogen of salmonids, particularly rainbow trout. The main source of infection is probably carrier fish since it can be carried within the tissues of carrier fish. It is associated with temperatures over 10°. There are six serovars of *Y. ruckeri* classified as Strains I through Strain VI, with Strain I being the most common.

Morphology: It's a motile gram-negative rod of size 0.5 – 0.8 × 1.0 – 3.0 µm. This disease most commonly affects younger rainbow trout.

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Symptoms: The early stages of this disease may resemble MAS with petechial hemorrhages observed around the fin and on the skin. Additionally, there is discoloration of the dorsum of the fish, as well as anorexia and lethargy. With chronic disease, there is ascitic fluid and unilateral or bilateral exophthalmos and hyphema (hence the term, “blood spot disease”). The characteristic gross lesions of this disease include hemorrhage of the oral cavity and skin erosions of the mouth. Histopathology includes bacterial colonization of wellvascularized tissues and hemorrhage of the gills, kidney, liver, spleen, and heart, as well as muscle.

Treatment: Control may be achieved with sanitary measures, provided care is taken to remove dead and dying fish and in tanks and raceways, bio-film removal is practised at each restocking, and the original stressors are removed, but antibiotic therapy is usually also necessary.

4. Furunculosis

Furunculosis is a serious, septicemic, bacterial disease found principally in salmonid fishes. But it may also occur in goldfish and other cyprinids. The common name of the disease is derived from the presence of “blisters” or furuncules on the surface of chronically infected salmonids. The disease is caused by a gram-negative bacterium, *Aeromonassalmonicida*described by Griftin et al. (1953).It is an obligate pathogen of fish.

Symptoms:

- **Peracuteform** (fingerlings): Dark discoloration and rapid mortality
- **Acute form**: Anorexia, hemorrhage of the liver and splenomegaly occurs 2-3 days prior to death.
- **Subacute**: Slower onset of petechial hemorrhages skin and fins, focal discolorations and anorexia and die approximately 4-6 daysafter the onset of clinical signs. Typical “furuncles” are observed.
- **Chronic**: Fish which survive the subacute form by healing of the furuncles and scarring faces chronic forms.

Treatment: Terramycin (oxytetracycline) and Sulfamerazine shows good result against furunculosis.

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5. Enteric Septicemia of Catfish (ESC)

It is caused by *Edwardsiella ictaluri.* This is probably the most important bacterial disease of channel catfish but occasionally reported in other ictalurids too. This is a markedly seasonal disease, with outbreaks occurring when water temperatures are in the range of 24 - 28 ^{o}C

Morphology: The organism is a gram-negative rod (0.5 × 1.3 µ m), motile at 25° C but not 37° C.

Symptoms: It cause colonization of internal organs with resultant necrosis of these organs. Clinical signs may include corkscrew spiral swimming, abdominal distention, exophthalmos, or pale gills. Petechial hemorrhages may be observed on dark areas of the skin as small (1 to 3 mm) depigmented foci (called "false spots"). Internally, the peritoneal cavity contains a bloody or clear fluid, hemorrhage and necrosis of the liver, as well as splenic and renal hypertrophy. In case of chronic condition the infection spreads from the meanings to the skull and finally the skin, forming the classic "hole-in-the-head" lesion.

Treatment: Vaccination offers the most significant prospect for control. The pathogen is strongly immunogenic, and immune carriers do not seem to occur.

6. Bacterial Kidney Disease (BKD)

This disease is caused by *Renibacterium salmoninarum* and primarily affects salmonids, especially rainbow, chinook, coho, brown and brook trout. Any age fish is susceptible to this disease, but losses may not occur until the fish are well grown. Vertical transmission of the disease from parent to offspring is thought to be the most common route of infection, however, horizontal transmission can also occur.

Morphology: The coryneform bacteria responsible for this disease are small, strongly Gram - positive, non-motile rods (0.3 – 1.0 × 1.0 – 1.5 µm), often occurring in pairs and in V formation.

Symptoms: Clinical disease is most likely to occur during times of stress, especially during transfer of salmonids from freshwater to seawater, or during spawning. Fish with BKD may have no external lesions yet small vesicles on the flanks (often called "spawning rash") filled with fluid, rupture to form cutaneous ulcers are seen. The major target organ is the kidney. *Renibacterium salmoninarum* is an extremely fastidious organism and may require up to twelve weeks to culture using selective media.

Treatment: A good managing practice helps to control disease from its occurrence. Sulphonamide and antibiotic therapy have been attempted but the infection may well be generalised before its presence is even suspected.

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7. Motile Aeromonas Septicemia (MAS)

Several other species of *Aeromonas*, including: *A.hydrophila, A. formicans, A. liquefaciens,* and *A. hydrophila*complex are capable of causing a disease known as "Motile Aeromonas Septicemia" or "bacterial hemorrhagic septicemia". This is probably the most common bacterial disease of freshwater fish. *A. hydrophila* is widely distributed in the aquatic environment. The organism is found in clean as well as organically polluted fresh water and in marine systems. It also forms part of the intestinal flora of healthy fish.

Morphology: It's a gram-negative, motile, straight rods (0.3 – 1.0 × 1.0 – 3.5 µm).

Symptoms: Clinical signs of motile aeromonas septicemia range from sudden death with high morbidity in peracute cases to superficial to deep skin lesions. Skin lesions include variously sized areas of hemorrhage and necrosis and the base of the fins leading to reddish to grey ulcerations with necrosis of the underlying musculature. Other clinical signs are exophthalmos, ascites, visceral petechiation, and a hemorrhagic and swollen lower intestine and vent.

Treatment: The condition can usually be controlled by treatment with antibiotics or potentiated sulphonamides.

8. Mycobacteriosis

It is caused by *Mycobacterium marinum.* This bacterium was first isolated from marine fish in the Philadelphia Aquarium by Aronson (1926). It is also called as *Fish Tuberculosis, Picine Tuberculosis, Swimming Pool Granuloma, Fish Tank Granuloma, Fish Handler's Disease, Fish Handler's Nodules.* The morphology is not distinctive.

Morphology: They are aerobic, gram-positive, pleomorphic rods which are members of the family Mycobacteriaceae.

Symptoms: *M. marinum* infections occur in both tropical marine and freshwater fish. The condition is thought to be spread from fish to fish by ingestion of infective material. The microorganism also causes

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'swimming pool granuloma' in man but infections may also be acquired from tropical fish aquaria. It also causes a hypersensitivity rash on the arms of aquarists who expose themselves to infected water. Affected fish may be cachexic, darker in colour, and show swelling of the abdomen. Tubercles may be found in liver, spleen and kidney.

Treatment: No treatment is known and affected stock should be destroyed.

9. Fin and Tail Rot Disease:

Fin and Tail Rot disease is caused by *Aeromonas salmonicida* and *A. liquefaciens.* Even, protozoans and fungi may also cause this infection.

Symptoms: It is characterized by appearance of white lines along the margins of fins, the opacity usually progresses towards the base eroding them and causing haemorrhage. The fin rays become brittles first and later break leading to the complete destruction of the fins. The infection may also spread on the body surface. Fin and tail rot are associated with poor sanitary conditions in fish ponds and with water pollution in nature.

Treatment: The Fin and tail rot may be checked at an early stage by keeping fishes in 0.5% copper sulphate solution for 2 minutes. Control may be achieved with1-2 ppm of benzalkonium chloride and 10-50 ppm tetramycin. In severe infections the affected parts are surgically removed and the fishes are then kept in 0.04% potassium dichromate.

10. Dropsy Disease:

Dropsy is caused by bacteria *Pseudomonas punctata*.

Symptoms: It is characterized by accumulation of yellow coloured fluid inside the body cavity, protruding scales and pronounced exopthalmic conditions. This is commonly known as "Intestinal Dropsy". In case of ulcerative dropsy, ulcers appear on the skin, deformation of back bone takes place and show abnormal jumping. This is a fatal disease in culture systems.

Treatment: Removal and destruction of fishes, followed by draining, drying and disinfecting the pond with lime are preventive measures to control the disease. The infected fishes may be cured with 5 ppm potassium permanganate for 2 minutes dip bath. Oxytetracyclin and Streptomycin give good results.

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9. Vibriosis

Historically, vibriosis is one of the oldest recognised infectious diseases of fish. The causative agent is *Vibrio anguillarum*. *V. anguillarum*has been shown to be a homogeneous species, distinct from other occasional fish pathogenic vibrios such *as V. vulnificus*and *V. harveyi*. *Vibrio anguillarum* is commonly found in marine and estuarine environments with a wide range of salinities and is readily isolated from marine invertebrates.

Morphology: It's a gram-negative, motile, curved or straight rods (0.5 × 1.5 – 2.5 μ m).

Symptoms: First signs of losses, affecting most susceptible fish, are often anorexia, darkening and sudden death; in young turbot and salmonids these may be the only signs, although periorbital and/or abdominal dropsy may also develop. Acutely affected fish show swollen, dark, skin lesions which ulcerate to release blood - coloured exudate. The ulcers may be very deep and necrotic. Internally, the main feature is enlargement and liquefaction of the spleen, petecchiation of visceral and parietal peritoneum. Focal haemorrhages may also be seen on the surface of the heart and the gills are usually paler. Gills usually remain pale. Immunisation and genetic selection have been shown to improve the resistance of salmonids to infection with Vibriosand commercial Vibrio vaccines are now available.

Treatment: Oxytetracycline, potentiated sulphonamides or nitrofurans are the most commonly used drugs, but since they are usually given orally, anorexic fish do not receive the drug. Vaccination is now so effective.

Prevention and Control of Fish Diseases

Health management in aquaculture production describes the management practices to prevent and control the occurrence of diseases. The goals of fish health management should be to:

• Prevent introduction of disease to healthy fish.
• Prevent propagation of existing disease agents.
• Enhance the natural resistance of fish.
• Produce healthy, high quality fish.

Most diseases affecting fish are stress related, thus an effective disease prevention and control practices should center on:

- Good husbandry (management) practices;
- Good water quality management,
- Nutrition and sanitation.
- Disease-free water supply.
- Limited introduction of organic matter to the pond water.
- Proper feeding
- Maintaining a suitable stocking density
- Proper handling of fish.
- Fish feed should be hygienic and nutritious.
- Stocking healthy seeds.
- Biosecurity
- Surveillance and reporting

CONCLUSION

Addressing health issues with both proactive and reactive programmes has become a primary requirement for sustainable aquaculture production. However, the rural farmers with little or no knowledge of aquaculture are still the most involving in aquaculture production. Moreover, most of them do not understand the signs of diseases. As such, this has put the impacts of disease on fish production on a relatively more severe level. It is therefore of critical importance to focus efforts not only on the prevalence of diseases and pathogens but also on the development of farmer oriented health management programmes on simple diagnostic procedure and effectiveremedial action. Healthmanagement is a shared responsibility, which calls for appropriate contributions from every stakeholder towards the actualization of the health management goals and in turn sustainable aquaculture production.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Integrated Pest Management in Groundnut Crop Ecosystem

Article id: 22851

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INTRODUCTION

Groundnut (*Arachis hypogaea* L.) belonging to the family Leguminaceae is one of the dominant oilseed crop of many sub-tropical and tropical countries of the world covering half of the area under oilseeds. It is important source of edible oil (fourth most) and vegetable protein (third most). India and China are the largest producers of groundnut. Overall world production, China shares about 41.5 per cent followed by India (18.2%) and USA (6.8%). The world average production of groundnut is 44.92 million metric tonnes. India where the yields are usually low because of many biotic and abiotic factors lead to low productivity of groundnut. Insect pests represent a major yield constraint in groundnut by direct damage or as vectors of virus diseases. Over one hundred insect species have been reported on groundnut in India. However, only a few of these cause economic losses.

Insect pest of ground nut and damaging symptoms:

1. **Red hairy caterpillar (RHC),** *Amsacta albistriga and Amsacta moorei* (Arctiidae, Lepidoptera)

   The caterpillars in early stages are found in groups on the underside of the leaves and feed on them by scrapping.Later they disperse to surrounding plants and defoliate plants. In years of severe out breaks, field after field may have to be re-sown in the beginning of the season and later on it becomes too late even for re-sowing

2. **Groundnut leaf miner,** *Aproaerema modicella* (Gelechiidae: Lepidoptera)

   Newly hatched larvae mine into tender leaf lets between epidermal layers and feed by making galleries. Larvae are found on the leaves, if a mine is opened, the minute caterpillar can be seen inside. The infestation is usually detected by the presence of small brown blotches on the leaf. Plant become stunted and die when severely infestation under dry conditions. A severely attacked field looks like 'burnt' from a distance.

3. **White grub / Root grub / May beetles**, *Holotrichia serrata, Holotrichia consanguinea* (Scarabaeidae: Coleoptera)

   Grubs feed on roots and fine rootlets of groundnut, as a result of which the plants become pale and wilted in appearance and ultimately dry up. Grubs cut end of the stem, and the affected plants, can be easily pulled. Severely damaged plants appear as if drying from drought (clumps dry up).

4. **Tobacco caterpillar,** *Spodoptera litura* (Noctuidae: Lepidoptera)

   The early instars are gregarious and scrape the chlorophyll content of leaf lamina giving it a papery white appearance. Larvae feed gregariously for first few days and then disperse to feed individually. Later irregular holes are made on the leaves. During later instars, they skeletonize the leaves leaving only veins and petioles. During flowering and pod/capsule formation stage, the caterpillars also feed on the internal contents of capsules and cause irregular holes.

5. **Groundnut aphid / Bean aphid / Cowpea aphid / Black fly / Bean black aphid**, *Aphis craccivora,*(Aphididae: Homoptera)

   Both nymphs and adults suck sap from tender leaves and shoots of plant causing the leaves to curl and growth to be stunted. Excrete honey dew on which sooty mould develops which interferes with photosynthetic activity of plants. The groundnut aphid also transmits groundnut rosette virus and sometimes groundnut stunt virus diseases.

6. **Groundnut pod bug,** *Elasmolomus sordidus*, (Lygaeidae:Hemiptera)

Both nymphs and adults suck sap from developing seeds of groundnut pods in the field. As a result, the seeds get shriveled and become rancid and give bitter taste. The oil content and germination percentage of infested seed is also adversely affected.

7. **Groundnut leaf hoppers,** *Empoasca kerri, Empoasca fabae* and *Empoasca flavescens* (Cicadellidae: Homoptera)

Both adults and nymphs suck sap from young leaves, mostly from the lower surface. The first symptom of attack is a whitening of the veins. Yellow patches then appear, especially at the tips of leaflets. Under severe infestation, the leaf tips become necrotic in a typical 'v' shape, giving the crop a scorched appearance known as 'hopper burn'

8. **Groundnut thrips,** *Caliothrips indicus, Scirtothrips dorsalis* and *Frankliniella schultzei,* (Thripidae: Thysanoptera)

Adults and nymphs scarp the leaf surface, hide inside the folded leaves and suck the oozing sap. The injury results in development of dull yellowish-green patches of the upper leaf surface and brown necrotic areas of the lower surface, initially resulting in white patches on the upper and necrotic patches on the lower surface of the leaves.

9. **Pod borer,** *Helicoverpa armigera,* (Noctuidae: Lepidoptera)

Larvae damages by boring into fruits and feed on inner contents of the pods. The entry hole is large and typically circular.

10. **Termites,** *Odotetermes obesus,* and *Trinervitermes biformis* (Termitidae: Isoptera)

Termites penetrate and hollow out the tap root and cause wilting and premature death of the plant. It also feed on the pod shell and scarify the pods externally rendering them more susceptible in invasion by soil fungi that can attack seeds, usually such seeds rot.

11. **Bihar hairy caterpillar,** *Spilosoma oblique,*(Arctiidae: Lepidoptera)

Young larvae feed gregariously on the under surface of leaves. Feed on leaves and cause loss by defoliation. In severe cases only stems are left behind.

12. **Jewel beetle,** *Sphenoptera indica*, (Buprestidae: Coleoptera)

Wilting of plants in patches. Grub burrows into stem close to soil surface and kills plant. Infected fields show dead and drying plants, which when potted up and examined grub/pupa can be seen in hollowed stem.

IPM practices on Groundnut:

Cultural practices:

- Deep ploughing in summer to expose soil-borne pathogens, white grubs, nematodes and hibernating defoliators.
- Soil application of castor cake/neem cake @ 250 kg/ha against termites.
- Use of trap crops such as cowpea/soybean (for leaf miner and leafhopper) and castor (for *spodoptera*) as border crops.
- Growing tall crops like pearl millet, maize or sorghum as border to reduce the incidence of thrips, vector for peanut stem necrosis disease.
- Vegetative trapping of RHC with twigs of jatropha or calotropis, neem branches for trapping adult white grubs.

Mechanical control:

- Erection of bird perches@10-12/ac
- Installation of bonfire against red hairy caterpillar (RHC) in endemic areas.
- Trenching and destruction of migrating larvae of hairy caterpillar
- Collection and destruction of white grub beetles from neem trees after the early rains.
- Collection and destruction of egg masses, early instars larvae of *Spodoptera, Spilosoma*, late instars larvae of *Helicoverpa* and defoliators.

Behavioural/ Botanical and Biological control:

- Pheromone traps @ 10 traps/ha for *Spodopter*a and *Helicoverpa* and 25 traps/ha for leaf miner or light trap (RHC)
- Spraying NSKE 5% or commercial neem formulations or neem oil@ 5 ml/litre defoliators and sucking pests.
- Release of *Telenomus remus* @ 50000/ha in 4 times (7-10 days interval) against defoliators (tobacco caterpillar) based on pheromone trap catching.
- Release of *Bracon hebetor* @ 5000/ha in 2 times at 7-10 days interval against leaf miner and defoliators.
- Augment the release of *Cheilonemus sexmaculata*, @ 1250/ha against *Aphis craccivora*.
- Spray Sl NPV/ Ha Npv 250 LE/ha or *Bacillus thuringiensis* @ 1 g/l litre against *Spodoptera litura* and *Helicoverpa armigera*.
- *Nomuraea rileyi*- spraying 2×10^{11} conidia/liter against *Spodoptera litura*.

ETLs for important insect pests of groundnut

- Spodoptera and other defoliators: 20-25% defoliation up to 40 DAS.
- Leaf miner: 5 mines/plant up to 30 DAS, 10 mines/plant up to 45 DAS.
- Thrips: 5 adults/ terminal bud
- Leafhopper: 5 to 10 adults/plant up to 30 days

Chemical control:

- Leaf miner, hairy caterpillars & defoliators: spraying quinalphos 2 ml/l or chlorpyriphos 2.5 ml or thiodicarb 1.5g /l.
- Sucking pests (aphid, jassid, thrips): seed treatment with imidacloprid @ 2 ml/kg, spray imidacloprid or acetamiprid @ 0.3 ml/l.
- White grub: Seed treatment with chlorpyriphos 20 Ec @ 6ml/kg, soil treatment with clothianidin 50WDG 120g a.i./ha

Resistant varieties:

- Gimar 1 (Jassid), ICGV 87160 (Aphids), Kadiri 3, BG 2 (*Spodoptera*), Vasundhara (Dh 101), and Pratap Mug- phalli 1 for Thrips, Leafminer and *Spodoptera litura*.

CONCLUSION:

Since most of the major pests occur throughout the world, various control measures need to be suitably integrated to cover a broad spectrum of pests. The approach, therefore, should be an integrated protection of the crop rather than integrated management of individual pest. Unfortunately, serious efforts were not made in the past to integrate the various pests control measures and as such research on integrated pest management in groundnut is still in its infancy.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Soil carbon sequestration to mitigate climate change

Article id: 22852

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INTRODUCTION

Current trends point to continued human population growth beside climate change increase the pressure on improving the capacity of agricultural system to produce food and fiber without further sacrificing the regional and natural resources. Climate change has immense effects on agriculture and therefore human hunger currently and in the decades ahead. According to IPCC the earth's mean temperature is projected to increase by 1.5–5.88°C during the 21st century. In addition to the sea-level rise of 15–23 cm during the 21st century. These and other observed climate changes are reportedly caused by emission of greenhouse gases (GHGs) through anthropogenic activities. It is estimated that they are still responsible for about one The increase in atmospheric concentration of CO_2 31% since 1750 from fossil fuel combustion and land use change necessitates identification of strategies for mitigating the threat of the attendant global warming (Keith, 2009). There is a strong interest in stabilizing the atmospheric abundance of CO_2 mitigate the risks of global warming.

Climate change will affect all four dimensions of food security; food availability, food accessibility, food utilization and food systems stability. Food availability; Changes in climatic conditions have already affected the production of some staple crops, and future climate change threatens to exacerbate this. Higher temperatures will have an impact on yields while changes in rainfall could affect both crop quality and quantity. Food accessibility; It covers access by individuals to sufficient resources (Entitlements) to gain proper foods. This dimension is affected by the higher food prices resulted from decreased crop yield, loss of income because of the potential increase in damage to agricultural production etc. Food stability; The climatic variability produced by more frequent and intense weather events can upset the stability of individuals' and government food security strategies, creating fluctuations in food availability, access and utilization. Food utilization; Climate-related risks affect calorie intake, particularly in areas where chronic food insecurity is already a significant problem. Changing climatic conditions could also create a vicious cycle of disease and hunger. Nutrition is likely to be affected by climate change through related impacts on food security, dietary diversity, care practices and health. Before human-caused CO_2 emissions began, the natural processes that make up the global "carbon cycle" maintained a near balance between the uptake of CO_2 and its release back to the atmosphere. However, existing CO_2 uptake mechanisms (sometimes called CO_2 or carbon "sinks") are insufficient to offset the accelerating pace of emissions related to human activities. Atmospheric concentrations of carbon dioxide can be lowered either by reducing emissions or by taking carbon dioxide out of the atmosphere and storing in terrestrial, oceanic, or freshwater aquatic ecosystems. There are several technological options for sequestration of atmospheric CO_2 into one of the other global pools. These can be grouped into two broad categories; abiotic and biotic sequestration. The abiotic sequestration involves the oceanic injection, geological injection, and scrubbing and mineral carbonation whereas; the biotic sequestration involves oceanic sequestration, terrestrial sequestration and secondary carbonates. Terrestrial sequestration (sometimes termed "biological sequestration") is typically accomplished through forest and soil conservation practices that enhance the storage of carbon or reduce CO_2 emissions such as reducing agricultural tillage and suppressing wildfires (Sauerbeck, 2001).

Soil carbon sequestration

Soil is a large reservoir of carbon, with about 60% organic carbon in the form of soil organic matter (SOM), and the remaining inorganic carbon in the form of inorganic compounds (e.g., limestone, or $CaCO_3$). It is estimated that SOM stores about twice as much carbon as the atmosphere, and about three times more than forests and other vegetation. Soil carbon sequestration implies transferring atmospheric CO_2 into long-lived pools and storing it in soil securely for long term to either mitigate or defeat global warming and avoid dangerous climate change so it is not immediately reemitted. Simply we can say that soil carbon sequestration is the process of transferring carbon dioxide from the atmosphere into the soil through crop residues and other organic solids, and in a form that is not immediately reemitted. Therefore, soil C sequestration means increasing the soil organic carbon (SOC) and soil inorganic carbon (SIC) stocks through judicious land use and recommended management practices (**Table 1**).

Table 1. Soil carbon sequestration in agricultural system with management practices

Management practices	Effect
Minimum or zero tillage	Reduced carbon loss
Erosion control i.e. contour cultivation	Reduced carbon loss
Addition of organic matter (compost, manure, crop residues)	Enhanced carbon input
Cover crops	Reduced carbon loss/ Enhanced carbon input

How is carbon sequestered into soils?

Soil organic matter originally comes from atmospheric CO_2 that is captured by plants through the process of photosynthesis. When plants die and decompose, some CO_2 is sequestered in the soil, while some is released back to the atmosphere. The primary way to sequester carbon in the soil is to add organic soil amendments such as compost or animal manures. Soil organic matter is a complex of carbon compounds, and includes everything in or on the soil that is of biological origin (Franzluebbers *et al.,* 2001). It includes plant and animal remains in various states of decomposition, cells and tissues of soil organisms, and substances from plant roots and soil microbes. Organic carbon in the form of humus, the dark, spongy organic matter in soils, is highly resistant to soil microbial decomposition. It can be stored in the soil for hundreds to thousands of years, while other SOM (e.g., partially decomposed plant residues) can be quickly released as CO_2 back into the atmosphere.

Paybacks of soil carbon sequestration

In addition to reducing current atmospheric CO_2 levels, increasing soil carbon sequestration can provide other benefits for soil quality, the environment, and agricultural production:

- Increased agricultural productivity.
- Increased water use efficiency, due to reduced moisture loss from runoff, evaporation, deep drainage below the root zone.
- Increased water holding capacity.
- Reduced fertilizer (N, P) needs over the longer term.
- Improved soil structure.
- Increased infiltration capacity.
- Increased soil fertility.

- Improved soil health resulting in higher nutrient cycling and availability.

Ways of soil carbon sequestration

The following management practices can increase soil carbon sequestration and help mitigate climate change:

1. Add organic soil amendments such as compost, animal manure, biosolids and organic mulch.
2. Grow bio-energy crops which are grown specifically for their fuel value to make biofuel (e.g., switch grass) on marginal lands.
3. Add biochar to the soil. Biochar is a microbially resistant carbon substance which is produced by heating organic wastes such as crop residues or wood chips in the absence of oxygen by a process called pyrolysis.
4. Leave crop residues on the soil without open burning.
5. Practice organic, biological, or biodynamic farming or gardening methods (management practices that restore, maintain, and enhance ecological balance).
6. Adopt no-till or minimum till to avoid mechanical disturbance of the soil.
7. Adopt crop rotations with cover crops in the rotation cycle.
8. Shorten or eliminate summer fallow periods.
9. Apply agronomic rates of nitrogen fertilizers to increase soil fertility and crop production.
10. Switch from single crop farming to more diverse practices such as pasture, crop and pasture rotation, inter-cropping (growing two or more crops close to each other), pasture cropping (sowing crops such as cereals into pastures), and agro-forestry (combining trees or shrubs with crops or pasture).
11. Enhance biological nitrogen fixation through the use of legume crops such as alfalfa.

CONCLUSION

The atmospheric carbon-dioxide increased significantly after the post industrialization in 1860s, more especially in recent decades because of the burning fossil fuels, changes in land use pattern, and cultivation of the land for food production and projected to continue increasing if appropriate action is not taken at time. This increased poses a significant threat of global climate change. Therefore, in this context, soil carbon sequestration is one of the appropriate, flexible and possible ways to reduce the atmospheric carbon-dioxide levels and to store the captured carbon in to the soil for long term.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Centurion Bowl of Rice: Bamboo Rice

Article id: 22853
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Bamboo Rice though not true rice that we eat as staple food, is aromatic, short-grain white rice from bamboo seeds. It has pale green seeds having a sticky texture and bamboo leafy flavor that is enriched several health promoting photochemicals of nature such as antioxidants, vitamins and minerals. It has several health benefits and known to control blood sugar and cholesterol, constipation, reduce joint pains and diseases like rheumatoid arthritis and swelling. Diabetic patients are recommended to consume bamboo due to its low glycemic index of 20 instead of normal rice. There are several traders who are taking interest in trading of Bamboo rice and its nutitional potenciality can emphasize its inclusion in the list of nutricereals.

INTRODUCTION

Bamboo rice is a commonly known to the tribal people of southern India where it is locally known as 'moongil arisi'. Bamboo is a perennial grass and it flower once in its life time (~40 years). After the maturity of flower seeds which set are actually in shape of rice. This rice when cooked tastes similar to wheat or Japanese sushi rice. It is twenty five times costlier than normal rice (a kilogram of Bamboo rice costs Rs.500 as compared to normal rice which cost Rs. 20). This rice is becoming popular among health conscious people and now adoption is increasing.

Fig. 1 Flower (A) and Seed of Bamboo Rice (B) (adapted from Bamboo botanicals from UBC botanical garden)

e-ISSN: 2581 - 8317
Volume 2 – Issue 2 – February 2020

Fig. 2 Bamboo rice obtained after milling process (adapted from www.indiamart.com)

The transformation of flowers of Bamboo to seeds and after milling finally on to our serving plate in the form of rice is depicted in Fig. 1 and 2.

Importance of Bamboo rice:

1. Rich in carbohydrate, fiber and protein, vitamin B, calcium and phosphorous content.
2. Having low glycemic index.
3. Contains less or no fat content.
4. It removes toxic substances from the body.
5. It is also used to treat menstruation disorders, respiratory diseases and infections.

Fig. 3 Trading of Bamboo rice by Manitou (A) and Bliss tree (B) (Adapted from woodland foods, 2016)

Bamboo rice like any other rice is rich in various nutrients including carbohydrates, fiber and protein. As bamboo rice has low glycemic index compared to other varieties of rice, it is healthier option for diabetics. This rice also has low or no fat so good for obese people. It is rich in vitamin B, which is beneficial for pregnant women. It is enriched with calcium and phosphorous content which can serve as a remedy for joint pain. Considering the above health and nutritional benefits, bamboo rice is considered

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

healthier than rice obtained from paddy. Already some international and national trading company like Manitou, Bliss tree are engaged in supplying natural gluten free Bamboo rice (Fig. 3).

Looking at the current scenario of malnutrition in the world like nutria-cereals Bamboo rice can play a significant role in alleviation of malnutrition. Hence, there is focused need of exploring the hidden potential of bamboo rice for nutritional and health benefits of masses.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Effects of Mobile Radiations on Honey Bees

Article id: 22454

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INTRODUCTION:

Cell phone usage is a major public health concern because of potential risk of chronic exposure to low level of radiofrequency and microwave radiation that pulse off the phone antennae in close proximity to the head. These concerns have induced a large body of research, both epidemiological and experimental, in humans and animals. Honeybees are reliable indicators of environmental status and possess several important ecological, ethological, and morphological characteristics. In the present day situations the usage of the mobile phones and other electronic gadgets has been increasing enormously. The mobile phone radiations are the major cause of the electro pollution in the environment. The electromagnetic radiation (EMR) emitted from the cell phones is very harmful on human beings, plants, animals, micro-organisms in whole ecosystem. It is well known that the population of house sparrow has fallen down because of this reason. Same way the honey bees populations are also affected because of the EMR. There are various reasons for the decline of the honey bee populations, the effects of EMR can also be added into the list. Many researches were conducted to suggest that cell phone radiations are affecting honey bees very badly and have revealed that there is direct relationship between decline in honey bee populations and electromagnetic radiations.

Important Fact:

- Honey bee are one of the most important insects in our ecosystem, the decreasing population of these insects is a serious concern.
- One of the major causes Colony Collapse Disorder is due to increased mobile radiations. Both mobile towers and mobile phones emit radiations which impart adverse effects on the behaviour of the *Apis mellifera*, and its colony.
- Honey bees in their normal state produced sounds at lower frequencies around 450 Hz, and with lower intensity of normalized amplitude. But, when they were disturbed by mobile phones, they produced sounds with higher frequencies that reached 1.5 KHz and with higher intensity reaching 0.7 Normalized amplitude and this may be the reason behind their decline. Exposed high voltage transmission line is leading to low egg laying capacity (100/day) compared to normal and makes a better explanation of Colony Collapse Disorder (CCD). The honey storing capacity also declined due to loss of returning bees, at the end of experiment there was neither honey, nor pollen or brood nor bees in the colony.
- Mobile radiations adversely impacting other organisms also in the ecosystem, due to the exposure of the mobile radiations on cows and calves, it was noted that 32% of the calves developed nuclear cataracts, similar studies on the rabbits showed lens opacities. The impact on human beings is much adverse which leads to brain cancer and other cancer incidences when exposed for long term.

Effects of Radiations:

Honey bees are complex unsocial insects that provide a critical contribution to human agricultural food production. Recently a new phenomenon of sudden disappearance of bees with little sign of disease or infection has been reported from world. Bees simply leave the hives and fail to return. This is called as colony collapse disorder (CCD). This may be due to habitat loss, lack of hygiene in the hive, climatic factor, pesticide poisoning, viruses, and other pests and diseases. But recent investigation reveals that radiations of different kinds are affecting the population of insects and other organisms. In recent years the growing awareness of the ecological dangers and functional limitations of chemical pesticides has provided an incentive to investigate thoroughly the possible role of radiation mechanisms in chemoreception and temperature measurement in the insect world. Insects are generally more resistant to the effects of ionizing radiation than are mammals; the LD50 ranging from 10 to 300 kR in adult insects compared to a range of 0.5 to 1 kR for adult mammals. Mobile radiations also have great impact on the decreasing population of these species. Cell phone technology has revolutionized the telecommunication scenario in India. Due to its several advantages, cell phone technology has grown exponentially in the last decade. The numbers of cell phones and cell towers are increasing without giving due respect to its disadvantages. Mobile phone uses EMR in the microwave range (450-2100 MHz). In 2011, International Agency for Research on Cancer (IARC) classified mobile phone radiations on Group 2B- possibly carcinogenic. Recently, a sharp decline has also been noticed in commercial bee population in Kerala posing a serious threat to honeybees, hitting apiculture (the cultivation of bees on a commercial scale for the production of honey). The State has the highest density of mobile towers. Similar cases have been observed in Bihar, Punjab, Nepal and other parts of India and have been attributed to increasing electro pollution in the environment. When honey bee colonies were exposed with radiation, the honeycomb weight and area were reduced and returning time of honey bees increased compared to similar non-exposed colonies. The massive amount of radiation produced by mobile phones and towers is frying the navigational skills of honey bees and preventing them from returning back to their hives. The radiations lead to low egg laying capacity in queens or exposure of queen bees to cell phone radiation stimulates to produce only drones EMFs from telecommunication infrastructure interfere with bees biological clocks that enable them to compensate properly for the sun‘s movements, as a result of which, may fly in the wrong direction when attempting to return to the hive.

CONCLUSION:

Apis mellifera, a common honey bee is responsible for the 80% of the pollination among field crops and other flowering plants. Beekeeping is one of the oldest traditions in India, honey and bee products have great market demand. It makes the major income for most of our famers. The declining population of these species is a serious issue. The present studies clears that the Colony Collapse Disorder (CCD) is mainly due to electro-pollution by increasing mobile phone tower radiations. Most of the countries have restricted the use of mobile phones, but there are no such implementations in India. The mobile phones have great benefits in spite of all the harmful effect and hence complete ban on their usage is not acceptable. But its usage has to be minimized in order to conserve the honey bees. Albert Einstein has stated that man cannot live for more than four years if honey bees are extinct. Electro-pollution has to be taken into consideration with the other environmental pollutions as well.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Water Pollution: An Overview

Article id: 22855

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Water is a unique substance, because it can naturally renew and cleanse itself, by allowing pollutants to settle out through the process of sedimentation or break down, or by diluting the pollutants to a point where they are not in harmful concentrations. However, this natural process takes time, and is difficult when excessive quantities of harmful contaminants are added to the water. Humans are using more and more materials that are polluting the water sources that we drink from. Fertilizer use is 15 times higher today than it was in 1945. Beach closures are becoming increasingly common. The list of pollutants is long and the signs of water pollution surround us, but the point is this: we are dumping contaminants into the small portion of water on the planet that is fit for drinking.

INTRODUCTION

Water is one of the renewable resources essential for sustaining all forms of life, food production, economic development, and for general wellbeing. It is impossible to substitute for most of its uses, difficult to de pollute, expensive to transport, and it is truly a unique gift to mankind from nature. Water is also one of the most manageable natural resources as it is capable of diversion, transport, storage, and recycling. All these properties impart to water its great utility for human beings. The surface water and groundwater resources of the country play a major role in agriculture, hydropower generation, livestock production, industrial activities, forestry, fisheries, navigation, recreational activities etc. The freshwater ecosystems of the world comprise only about 0.5% of the earth's surface and have a volume of 2.84x105 Km3. Rivers constitute an insignificant amount (0.1%) of the land surface. Only 0.01% of the waters of the earth occur in river channels. India is gifted with river system comprising more than 20 major rivers with several tributaries. Many of these rivers are perennial and some of them are seasonal. Although India occupies only 3.29 million km2 geographical area, constituting 2.4% of the world's land area, it supports over 15% of the world's population. Water pollution occurs when energy and other materials are released, degrading the quality of the water for other users. Water pollution includes all of the waste materials that cannot be naturally broken down by water. In other words, anything that is added to the water, above and beyond its capacity to break it down, is pollution. In the last few decades, there has been a tremendous increase in the demand for freshwater due to rapid growth of population and the accelerated pace of industrialization (Ramakrishnaiah *et al*., 2009). Human health is threatened by most of the agricultural development activities particularly in relation to excessive application of fertilizers and unsanitary conditions. Anthropogenic activities related to extensive urbanization, agricultural practices, industrialization, and population expansion have led to water quality deterioration in many parts of the world (Baig *et al*. 2009, Mian *et al*., 2010, Wang *et al*., 2010). In addition, deficient water resources have increasingly restrained water pollution control and water quality improvement (Bu *et al*., 2010). Water pollution has been a research focus for government and scientists. Therefore, protecting river water quality is extremely urgent because of serious water pollution and global scarcity of water resources.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

What is water pollution?

"Water pollution" is defined as the addition of harmful or objectionable or toxic material causing an alteration of water quality. Water is considered polluted if some substances or condition is present to such a degree that the water cannot be used for a specific purpose. Olaniran (1995) defined water pollution to be the presence of excessive amounts of a hazard (pollutants) in water in such a way that it is no long suitable for drinking, bathing, cooking or other uses. Pollution is the introduction of a contamination into the environment (Webster.com, 2010).

How does water pollution occur?

Mankind through socio-economic activities introduce pollutants to the environment. ***"Then the Earth's waters cycle, carry and spread the pollutants all around the planet."***

Activities that contribute to water pollution

- Overgrazing
- Poor agricultural land management
- Removal of riparian vegetation
- Sewage, industrial, and domestic discharges
- Construction, Mining
- Release of gases and aerosols to the atmosphere
- Mismanagement of reservoirs
- Accidental spills

Sources of contamination for water pollution

- **For Groundwater:** Polluting substances leach into a water-saturated region [e.g. toxic chemicals]. Mainly due to migration of pollutants from sites with high concentrations of chemicals [e.g. industrial waste sites and farms].
- **For Surface water:** Rivers and lakes are polluted mainly contaminated by Sewage (municipal or private) waste and Industrial wastes.
- **Point Source:** Point sources of pollution are those which have direct identifiable source. Example includes pipe attached to a factory, oil spill from a tanker, effluents coming out from industries. Point sources of pollution include wastewater effluent (both municipal and industrial) and storm sewer discharge and affect mostly the area near it.
- **Non-Point Source:** non-point sources of pollution are those which arrive from different sources of origin and number of ways by which contaminants enter into groundwater or surface water and arrive in the environment from different non identifiable sources. Examples are runoff from agricultural fields, urban waste etc.

i. **Organic water pollutants:** They comprise of insecticides and herbicides, organ halides and other forms of chemicals; bacteria from sewage and livestock's farming; food processing wastes; pathogens; volatile organic compounds etc.

ii. **Inorganic water pollutants:** They may arise from heavy metals from acid mine drainage; silt from surface run-off, logging, slash and burning practices and land filling; fertilizers from agricultural run-off which include nitrates and phosphates etc. and chemical waste from industrial effluents.

Other Sources:

- ✓ **Urbanization:** Urbanization generally leads to higher phosphorus concentrations in urban catchments (Paul and Meyer, 2001). Increasing imperviousness, increased runoff from urbanized surfaces, and increased municipal and industrial discharges all result in increased loadings of nutrients to urban streams. This makes urbanization second only to agriculture as the major cause of stream impairment.
- ✓ **Sewage and other Oxygen Demanding Wastes:** Management of solid waste is not successful due to huge volumes of organic and non-biodegradable wastes generated daily. As a consequence, garbage in most

parts of India is unscientifically disposed and ultimately leads to increase in the pollutant load of surface and groundwater courses. Chemical fertilizers used by farmers also add nutrients to the soil, which drain into rivers and seas and add to the fertilizing effect of the sewage. Together, sewage and fertilizers can cause a massive increase in the growth of algae or plankton that facilitate huge areas of oceans, lakes, or rivers creating a condition known as algal bloom thereby reducing the dissolved oxygen content of water and killing other forms of life like fish.

- ✓ **Industrial Wastes:** Many of the industries are situated along the banks of river such as steel and paper industries for their requirement of huge amounts of water in manufacturing processes and finally their wastes containing acids, alkali's, dyes and other chemicals are dumped and poured down into rivers as effluents. Chemical industries concerning with manufacture of Aluminium release large amount of fluoride through their emissions to air and effluents to water bodies. Fertilizer industries generate huge amount of ammonia whereas steel plants generate cyanide. Chromium salts are used in industrial process for the production of sodium dichromate and other compounds containing chromium. All such discharges finally arrive at water bodies in the form of effluents affecting human health and the organism living there.
- ✓ **Agro-chemical Wastes:** In the agricultural sector, water and electricity for irrigation are subsidized for political reasons. This leads to wasteful flood irrigation rather than adoption of more optimal practices such as sprinkler and drip irrigation. Cropping patterns and farming practices also do not necessarily encourage the judicious use of water. Agro-chemical wastes include fertilizers, pesticides which may be herbicides and insecticides widely used in crop fields to enhance productivity. Improper disposal of pesticides from field farms and agricultural activities contributes a lot of pollutants to water bodies and soils.
- ✓ **Nutrient Enrichment:** The sources of nutrients in surface water can be divided broadly into natural and anthropogenic types. Contribution to pollution by natural source is low due to balance established by the natural system between the production and consumption of nutrients over the course of time. Anthropogenic sources of contaminants are contributed from agriculture, domestic and industrial wastes. Nutrient concentrations in streams and rivers have been strongly correlated with human land use and disturbance gradients. Both N and P enrichment have links with the agricultural and urban land uses in the watershed.
- ✓ **Oil Spillage:** Oil discharge into the surface of sea by way of accident or leakage from cargo tankers carrying petrol, diesel and their derivatives pollute sea water to a great extent. Exploration of oil from offshore also lead to oil pollution in water. The residual oil spreads over the water surface forming a thin layer of water-in-oil emulsion.
- ✓ **The Disruption of Sediments:** Construction of dams for hydroelectric power or water reservoirs can reduce the sediment flow affecting adversely the formation of beaches, increases coastal erosion and reduces the flow of nutrients from rivers into seas (potentially reducing coastal fish stocks). Increased sediment flow can also create a problem. During construction work, soil, rock, and other fine powders sometimes enter nearby rivers in large quantities, causing water to become turbid (muddy or silted). The extra sediment can block the gills of fish, causing them suffocation.
- ✓ **Acid rain pollution:** Water pollution that alters a plant's surrounding pH level, such as due to acid rain, can harm or kill the plant. Atmospheric Sulphur dioxide and nitrogen dioxide emitted from natural and human-made sources like volcanic activity and burning fossil fuels\interact with atmospheric chemicals, including hydrogen and oxygen, to form sulphuric and nitric acids in the air. These acids fall down to earth through precipitation in the form of rain or snow. Once acid rain reaches the ground, it flows into waterways that carry its acidic compounds into water bodies. Acid rain that collects in aquatic environments lowers water pH levels and affects the aquatic biota.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

- ✓ **Radioactive Waste:** Radioactive pollution is caused by the presence of radioactive materials in water. They are classified as small doses which temporary stimulate the metabolism and large doses which gradually damage the organism causing genetic mutation. Source may be from radioactive sediment, waters used in nuclear atomic plants, radioactive minerals exploitation, nuclear power plants and use of radioisotopes in medical and research purposes.
- ✓ **Thermal Pollution:** Changes in water temperature adversely affect water quality and aquatic biota. Majority of the thermal pollution in water is caused due to human activities. Some of the important sources of thermal pollution are nuclear power and electric power plants, petroleum refineries, steel melting factories, coal fire power plant, boiler from industries which release large amount of heat to the water bodies leading to change in the physical, chemical and biological characteristics of the receiving water bodies.
- ✓ **Carcinogens in Waste Water**: Wastes from certain industries or leakages of certain materials in handling, processing, etc. may have substances which can cause cancer in humans or animals. These carcinogenic substances may find their way in waste waters which may pollute the source of waters for general use. Many of the heavy and toxic metals (like nickel, chromium, radioactive substances, certain dyes, inks, resins, fumigants, gasoline additives, nitro phenyl, naphthyamines, benzidine, and some of the pesticides like D.D.T. etc. are carcinogens.
- ✓ **Pollution by e-waste:** India generated about 1050 tonnes of electronic scrap per year as reported in April 2005 which increased to 146,000 tonnes of e-waste per year as reported in May 2007. This would go on increasing year by year. A study by U.S. environmental protection agency shows that e-waste forms about 1% of municipal solid waste in USA. California alone discards 6000 computers daily. They have estimated that about 70% of heavy metals found in the landfills there, come from electronic discards which may contaminate ground waters. When e-waste is incinerated with other wastes it leads to hazardous emission-containing 'Dioxins'. The commonly found metals in e-waste like copper are catalyst for 'Dioxin' formation.

Types of Pollution

a. **Suspended Solids:** The inorganic suspended solids blanket the stream bed effecting benthos (flora and fauna at bottom of water) organisms, while the organic solids create sludge banks and decompose causing odours and pathogens.

b. **Floating Solids Including Oils, Greases:** Floating materials obstruct passage of light and aeration which are vital for flora and fauna and self-purification of water.

c. **Organic Matter:** Biological decomposition of waste organic matter in stream depletes dissolved oxygen content of water which may stifle the fish and aquatic life due to lack of oxygen. Unpleasant odour, flavour and taste, result due to lack of dissolved oxygen. Untreated sewage is the biggest pollutant and a cause of pathogens in water.

d. **Inorganic Dissolved Salts:** High total dissolved solids (TDS) may interfere with the use of water in industries, municipal supplies and for irrigation purposes. Phosphorus and Nitrogen are plant nutrients which induce algae growth and sometimes create 'Eutrophic' condition when excessive plant and algal growth may kill fishes and water animals. (Ground waters may also have some of the pollutants mentioned in case of surface waters such as heavy metals, high total dissolved solids (TDS), high salinity or sodicity, fluoride, arsenic, nitrates denoting organic pollution, pesticides, radioactivity, bad odours and flavour, colour, pathogens, etc.

Types of Pollutants

1. **Degradable**: degradable material breaks down into component parts within water and is normally organic residuals attacked and broken down by bacteria and become less harmful.
2. **Thermal Pollution**: caused by injection of heat into watercourses by an industrial plant or electric utility using surface water as a coolant, and returning the heated water to the watercourse.

3. **Plant Nutrients**: nitrogen and phosphorus in excess quantity leads to eutrophication in a lake which stimulates the growth of aquatic plant life, e.g. algae and water weeds and it also can produce bad odour if in excess quantity.
4. **Infectious Organisms**: bacteria and viruses are carried into both ground and surface water by domestic and animal wastes; industrial wastes e.g. tanning and meat packaging which contains live organisms that may thrive and multiply in water or decline.

Effects of pollutants on different components

a. **Effects on Agriculture:** Use of waste water and polluted surface and groundwater which contaminate crops and transmit disease to consumers and farm workers; Depositions of deleterious chemicals in soil leading to loss of soil fertility. Different types of effect occur; Effects of acid deposition: Many of the gases from acid, aerosols and other acidic substances released into the atmosphere from industrial or domestic sources of combustion from fossil fuels finally fall down to ground and reach the water bodies along with run-off rainwater from polluted soil surfaces thereby causing acidification of water bodies by lowering its pH. Nutrient deficiency in aquatic ecosystem: Population of decomposing microorganisms like bacteria and fungi decline in acidified water which in turn reduces the rate of decomposition of organic matter affecting the nutrient cycling. The critical pH for most of the aquatic species is 6.0.
b. **Effects on Environment and ecosystems:** pungent smell, decolourisation increased temps contamination change the pH decreased oxygen detergents that create a mass of white foam in the river waters; Enrichment of groundwater with salts, nutrients from irrigated lands.
c. **Eutrophication/algal blooms**: effect on recreational activities, water treatment plants/water providers; loss of aesthetic value; Algae clogs our waterways.
d. **Effects of Polluted Water on Economy:** Unsightly colour, reduced clarity, and obnoxious odour of the receiving waters also make it unfit for recreation and other productive uses. Adverse effects of water pollution lead to economic losses in terms of reduced health status reduced agricultural productivity, and low-quality tourism. There is an also economic loss to family income due to the desire for safe bottled water which is more expensive than unbolted water. When water is polluted, fish and other aquatic resources can perish, which leads to a decline in fisheries production.
e. **Effects on Human Health:** Increased incidence of tumours, ulcers due to nitrate pollution; Increased incidence of skin disorders due to contact with pollutants; Increased incidence of constipation, diarrhea, and infections to intestine; Dangerous effects on growing foetus in pregnant women; Concentration of pollutants due to bio-accumulative pesticides through secondary and tertiary food chains in case of non-vegetarians; Still births, abortions, and birth of deformed children; Blue baby disease caused by methaneglobiema which results in asphyxia (reduced oxygen supply);Reduced activity of immune system; Loss of memory power and reduced mental sharpness; Water borne diseases like jaundice, hepatitis, gastroenteritis, will be more.
f. **Effects on Animal Health:** Large scale death of aquatic animals take place due to Reduced reproduction rate, increased disease incidences and imbalances in secondary food chains.

- Accumulation of bio accumulative and non-biodegradable pollutants in animal bodies.
- Bio-magnifications cause health hazards like impotence, cancerous tumours etc.
- Oil spills in the water causes animal to die when they ingest it. Oil does not dissolve in water so it causes suffocation in birds and fishes.
- Ground water contamination from pesticides causes reproductive damage within wildlife in ecosystem.
- Water born infections/from parasites/other diseases causing microorganisms are transmitted via contaminated water.

Table.1 Major Water Borne Diseases

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Sl. No	Types	Diseases	Causes	Effects	Prevention
1.	Water borne disease causing vector carried in water.	Cholera, Typhoid, Diarrhoea, Dysentery	Drinking contaminated water, eating contaminated food	Dehydration	Use clean water for drinking, keep flies away from food, avoid unprotected water sources for drinking
2.	Water washed resulting from lack of water or improper use of water	Scabies Eye infections Diarrhoea	Not washing, lack of enough water for washing	Itchy lashes, Sore eyes, Blindness, Fever from lice diseases.	Increase water availability for washing, Improves personal hygiene.
3.	Water based (Vector lives in water)	Bilharzias	Worms from the snails enter through the skin in infected water	Blood in stool, pain in stomach	Reduce contact with infected snails, control snails with chemical spray.
4.	Insect vector related	Malaria, River blindness	Mosquitoes bites, Semolina worm	Fever, Aches, Blindness	Removal potential larvae breeding sites, Use mosquito netting, Introduce fish in ponds river water.

Control of Water Pollution

- ✓ Wash your car far away from any storm water drains and don't throw trash, chemicals or solvents into sewer drains.
- ✓ Inspects your septic system every 3-5 years.
- ✓ Avoid using pesticides and fertilizers that can run off into water systems.
- ✓ Use non-toxic cleaning materials.
- ✓ Clean up oil and other liquid spills with kitty litter and sweep them up.
- ✓ Avoid washing of paints brushes in the sink.
- ✓ A regular qualitative and quantitative monitoring of fresh water resources.
- ✓ Identify industrial units that are the biggest polluters of river water.
- ✓ Low levels of radioactive wastes in the water are removed by the oxidation of ponds.
- ✓ There must be a law made by the government the industries must treat the polluted water by the use of water hyacinth before the water discharged in to the river and sea.
- ✓ There should be ban on washing of clothes and laundry alongside the river bank.
- ✓ Industries should install Effluent Treatment Plant (ETP) to control the pollution at source.
- ✓ Improper use of fertilizers, herbicides and pesticides in farming should be stopped and organic methods of farming should be adopted.
- ✓ Religious practices that pollute river water by dumping colourful paints of idols containing harmful synthetic chemicals should be stopped.
- ✓ Rain water harvesting should be practiced to prevent the depletion of water table.
- ✓ Making people aware of the problem is the first step to prevent water pollution. Hence, importance of water and pollution prevention measures should be a part of awareness and education programme.

CONCLUSION

Water pollution is an environmental problem that is of major concern to us in Nigeria and the world at large. Human contribution to water pollution is enormous by way of defecating; dumping of refuse, industrial wastes and washing of clothes etc. Apparently, environmental education is of immense importance to use particularly in schools and should have a place in the school curriculum. Promote the water safety and quality control programmes to tackle the water pollutions such as; Safe Drinking Water Foundation has educational programs that can supplement the information found in this fact sheet. Operation Water Drop looks at the chemical contaminants that are found in water; it is designed for a science class and it has lessons that are designed for Social Studies, Biology, and Chemistry classes. Awareness programme's and strict rules has to be implemented by the government to fight against water pollution and also Human activities including industrialization and agricultural practices are strictly monitored by pollution control board on regular basis by using advanced technologies.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Protected cultivation of Gynoecious cucumber

Article id: 22856

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INTRODUCTION:

There are cucumber hybrids that produce fruits without pollination. These varieties are called parthenocarpic varieties, resulting in fruits that are called 'seedless', although the fruit often contain soft, white seed coats. Such parthenocarpic fruit set also occurs naturally under the lowlight, cool-night growing conditions, and short days of fall. Older plants can also produce 'super' ovaries which set fruit parthenocarpically. Greenhouse cucumbers are generally parthenocarpic.

Types of sex form in cucumber:

Sex expression in cucurbits is influenced by genetic, environmental and hormonal factors as described by Byers *et al.* Monoecious strains of cucumber (*Cucumis sativus* L.) bears staminate (male) and pistillate (female) flowers. Gynoecious strains normally produce only pistillate flowers. Other cucumber strains produce staminate or pistillate and in addition perfect (hermaphroditic) flowers in various combinations. For example, andromonoecious strains are those that begin with staminate flowers and eventually also produce hermaphroditic flowers.

Role of growth regulator in Sex expression:

Application of gibberellins promotes formation of male flowers in monoecious and gynoecious phenotypes of cucumber. Sex expression can be modified by day length and temperature. Generally, short days and cool temperatures favor femaleness, while long days and high temperatures favor maleness, although there are exceptions. Ethylene and 2-chloroethylphosphonic acid (ethephon), an ethylene-releasing compound, have recently been shown to promote femaleness in cucurbits.

Varieties:

- Parthenocarpic slicers include Sweet Success, Euro-American, Socrates, Tyria, Diva, Tasty Jade and Suyo Long.
- Gynoecious cultivars like Kian, Isatis etc. of cucumber are very popular in European countries.
- Indian gynoecious cutivars are Phule Prachi, Phule Champa, Satis, Alamir, Full star, King star, Pusa Sanyog

Growing requirements

Greenhouse cucumbers grow rapidly under optimum environmental conditions, and fruit production begins 60 - 70 days after seeding.

Relative humidity: 80% RH is suitable for growth and development. High humidity results in appearance of powdery mildew.

Light: Light level of 45000-50000 LUX is optimum for cucumber production.

Temperature: Optimum temperature is 23-34^{0}C. Above 40^{0}C and below 14^{0}C are not suitable for cucumber production.

Soil: Greenhouse cucumbers generally grow quite well in a wide range of soil pH (5.5-7.5)

Nursery maintenance:

Seedlings are grown in plastic pro-trays having 1.5” cell size in soil less media in month of December/January @ 500g/ha.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

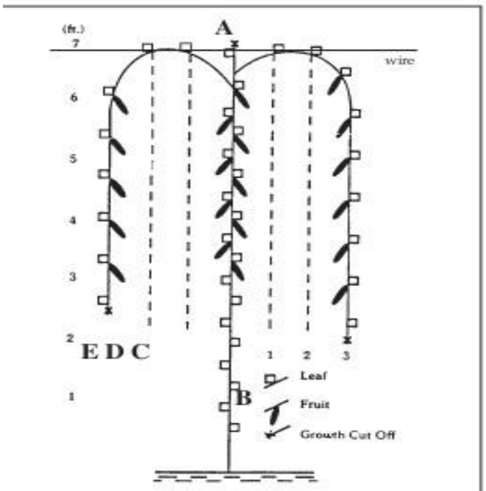
Soil preparation before planting:
Soil fumigation aids in the control of weeds and soil-borne diseases. Fumigation alone may not provide satisfactory weed control under clear plastic. Fertilizer must be applied during bed preparation. At least 50% of the nitrogen (N) should be in the nitrate (NO_3) form. Fumigation will be necessary when there is a history of soil borne diseases in the field.

Spacing: Beds of 1-1.5m width with walking space of 30cm is prepared. Within that row to row spacing of 90cm-1m and plant to plant spacing of 40-50cm is followed.

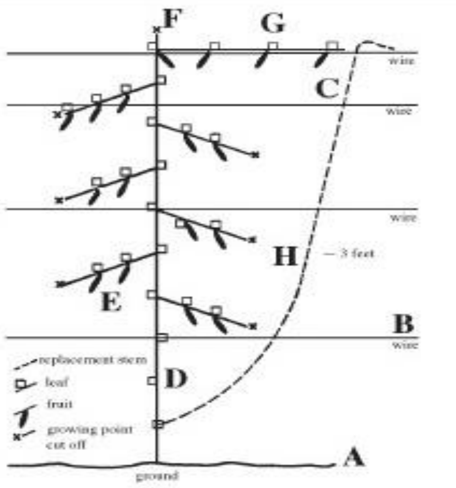
Fertilizer: NPK @ 150:90:90 kg/ha is sufficient which is applied through irrigation water.

Trellising: Cucumber vines can be trained on trellises to save space and improve yield and fruit quality. Greenhouse cucumbers must be trellised, because the long fruit bend if they rest on the ground.

A. **Umbrella system (for seedless varieties)**
Most of grower prunes the plants by umbrella system, where all the lateral branches are removed as the plants develop until they reach the overhead support. Then the terminal bud is removed after the second leaf above the wire and last two lateral branches allowed to grow and trained over the wire and then allowed to grow downward up to **3 feet** above ground. Fruits are not allowed to grow on the lower **30 inches** of main stem.



Umbrella System
A—Top wire. B—Support. C,D,E—Lateral fruiting stems.



Tree System
A—Ground level. B—Wire. C—Support string. D—Leaves and laterals remove. E—Fruiting area. F—Tip nipped out. G—Lateral trained along top wire. H—Replacement lateral.

B. **Tree trellis system: (for seeded varieties)**
The cucumber plants are tied to horizontal wires spaced 2 feet apart, top wire should be 6 feet from ground. All the leaves and laterals are removed on bottom 20 inches of plant. When main stem reach the wire it is tied and growing tip is removed. All the lateral at each leaf axis is allowed to develop two leaves, then growing point is cut. When most of the fruit has been harvested on main stem, a lateral is allowed to develop as replacement and pruned in the same manner as the main stem.

Pruning:
- Pruning start 15 days after germination.
- Branches, leaves, flowers and fruit should be pruned to maintain a proper balance between the vegetative and reproductive growth to maximize production.
- Too many fruits set at one time, may cause abort or fruit drop due to insufficient nutrients.
- Heavy load of fruit set cause malformed or poorly colored.

- Fruit loads should be thinned to one fruit per leaf axil.

Harvesting: Slicing cucumber is harvested within 40-50 days after planting and 12-15 days after flower opens. Cucumbers should be harvested at 2-4 day intervals. Pickling types are harvested when fruits are 5-7.5 cm long and slicing types are harvested when dark green, firm, 15-20 cm long with a diameter of 4-5 cm.
Yield: 100-300 t/ha under optimal temperature, humidity, light intensity and pollination, achieved under glasshouse).
Storage: cucumber can be stored at temperature 10^0 C with 85% RH for 10-14 days.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Integrated weed management in soybean (*Glycine max* L.)

Article id: 22857

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INTRODUCTION- Integrated Weed Management (IWM) is an approach to managing weeds using multiple control tactics. The purpose of IWM is to include many methods in a growing season to allow producers the best chance to control troublesome weeds. Weed management is essential for any current system of agricultural production, especially foe large monoculture areas, which exert high pressure on the environment. Disregarding the high cost, weed might be controlled in soybean crop using good management practices of all available methods, combining them in an integrated weed management (IWM). Crop rotation is rather efficient method, since it allows an easy control of the most troublesome weeds. In order to achieve success on crop rotation, weeds must be managed throughout the growing soybean season. Using full capacity of crop competition is another alternative, yet this tool is often overlooked. Most important weed species in soybean are *Amaranthus spinosus*, *Brachiaria reptans, Cleome gynanadra, Phyllanthus niruri, Trianthema portulacastrum.*

Integrated weed management in soybean

Cultural control- It largely involves manipulating farming practices to suppress weed growth and production, while promoting the development of the desired plant. Encourage the competitiveness of desired species that are more competitive and fast growing. This suppresses weed growth by reducing access to available sunlight, nutrients and moisture and can include:

- Choose plant and crop species or cultivars that are naturally more competitive. This can include using plant species that suppress other plant species by the release of toxins.
- Use high quality (large and plump) seeds, as they are more likely to produce vigorous and competitive plants.
- Use increased seeding rates and narrow row spacing.
- Use shallow seeding techniques, where possible, to allow the desired species to grow above the soil surface more quickly.
- Ensure the desired plant is placed in the optimum growing environment.
- Use fertilisers in the optimal growth period to encourage rapid growth of the desired species.
- If possible use plant species that are native to the local environment.

Make it hard for weeds to adapt to weed management techniques. Using the same land management routines year after year may result in weeds adapting to these practices. Some practices that make it hard for weeds to adapt and therefore reduce their spread and vigour include:

- Rotate crops: if a weed has adapted to grain crops continuously being sown, then alternating with a broadleaf crop will remove the environmental condition to which the weed has adapted.
- Rotate species with different seasonal and growing cycles.
- Rotate herbicides with different modes of action to help delay the development of herbicide resistance.

Physical control- Physical control is the removal of weeds by physical or mechanical means, such as mowing, grazing, mulching, tilling, burning or by hand. It is important that, when using physical control, any item that can move from a weed-infested site to an un-infested site, such as machinery, vehicles, tools and even footwear, is cleaned free of weed seed before moving, to stop the spread of weeds to new areas.

1. **Hay making, mowing and grazing**

Hay making, mowing and grazing before weeds produce seeds restrict the amount of weed seed in an area and reduce the spread of weeds.

2. **Mulching**

Mulching, by covering the ground with a layer of organic material, suppresses or kills weeds by providing a barrier between the weeds and sunlight. Mulching has an added advantage in that it improves the condition and moisture level in the soil.

3. **Tilling**

Tilling, the ploughing or cultivation method that turns over the soil, buries the weed beneath the soil. This provides a barrier to the sun, therefore killing the weeds. This method is useful for making soil ready for planting new crops, but it can lead to damage in soil structure and exposes the soil to erosion and further invasion by weeds.

4. **Burning**

Burning removes the above-soil body of the weeds killing most of the plants. If carried out before seed is set it can prevent the further spread of weeds. Burning can be undertaken over a wide area with minimal human input. As with tilling, burning exposes the soil surface to erosion. If burning is used as a control method, caution should be exercised to minimise the risk of harm to the environment and to those undertaking the activity.

5. **Hand removal**

Removal by hand, including hoeing, is a good method for selective removal of weeds without disturbing the surrounding desirable vegetation.

Biological control- The biological control approach makes use of the invasive plant's naturally occurring enemies, to help reduce its impact. It aims to reunite weeds with their natural enemies and achieve sustainable weed control. These natural enemies of weeds are often referred to as biological control agents. Although in the long term, biological control can be cost effective and can reduce the need for less desirable management practices, not all weeds are suitable for biological control. Developing a biological control project requires a substantial investment, sometimes costing millions of dollars over many years.

Chemical control- Although the use of chemicals is not always essential, herbicides can be an important and effective component of any weed control program. In some situations herbicides offer the only practical, cost-effective and selective method of managing certain weeds. Because herbicides reduce the need for cultivation, they can prevent soil erosion and water loss, and are widely used in conservation farming.

In some cases, a weed is only susceptible to one specific herbicide and it is important to use the correct product and application rate for control of that particular weed. Common mistakes include incorrect identification of the weed or using inappropriate products. In most cases, weeds must be actively growing to be vulnerable to herbicide treatments.

Pre herbicides	PPI herbicides
Fluchloralin(1.0-1.5)	Alachlor(1.5-2.0)
Acetochlor(1.0-1.5)	Clomazone(0.75-1.5)
Vernolate(1.5-2.5)	Metribuzin(1.0-1.5)
Trifluralin(0.75-1.0)	Chlorimuron ethyl(0.004-0.008)
	Metolachlor(1.0-1.5)
	Trifluralin(1.5-2 .0)
	Lactofen(1.0-1.5)
	Oxyfluorfen(1.0-1.5)
	Imazethapyr(0.10-0.50)
	Imazethapyr(50-60g)

CONCLUSION- Weed management has always been inserted into the soybean crop system, contributing decisively to the success of this crop in major producing countries nowadays. Even with prediction models to IWM implementation, weed control is not indefinitely assured if it is not continuously adapted to new changes in soybean production system. In this context, there is no single solution, ready and with indeterminate validity on weed management. Choosing intelligent systems, which integrate the basic concepts of ecology and biology of species to the available tools (GM crops, herbicides, biological control, etc.) should assist weed management.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Phytoextraction of Heavy Metals - A Promising Tool for Clean-up of Polluted Environment

Article id: 22858

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INTRODUCTION:

Conventional physical and chemical methods of heavy metal removal from a polluted environment are usually not usable at large scales as they are not economically viable, socially acceptable and ecologically sustainable. In contrast, bioremediation i.e., the use of living organisms or their parts for remediation, is a group of methods that are highly applicable in large contaminated areas, especially in cases where the removal of heavy metal contamination is not urgent (Khalid et al., 2017). Generally, the most yet-employed strategies on how to remediate an heavy metal polluted environment are based either on their stabilization *in situ*, i.e., reducing heavy metal acute toxicity through decreasing their mobility and bioavailability (so-called "site stabilization" techniques), or are based on heavy metal removal (the group of "clean-up" techniques). When using plants, the former group is referred as *Phytostabilization*. Among the clean-up techniques, *Phytoextraction* employs plants for the extraction of heavy metals from soils and their accumulation in harvestable parts, which are subsequently removed and further processed (Chaney et al., 1997). *Phytovolatilization*, another subgroup of clean-up techniques, represents the conversion of heavy metal / metalloids such as Hg, As, and Se into a volatile form via biological conversion within plants, and their release into the atmosphere (Tangahu et al., 2011). Despite decreasing the pollution locally, this group of techniques contributes to the pool of mobile forms transportable over long distances, and is somewhat controversial.

What is Phytoextraction?

Plants have the ability to absorb high amounts of heavy metals, while their growth remains unaffected. The technology of using plants for removing heavy metals from soil is called "phytoextraction". It has been discovered that plant-metal interaction can be utilized for industrial and environmental benefits. As a cost effective and eco-friendly alternative, the use of plants to remedy soils contaminated with inorganic and organic xenobiotics has gained increasing attention in recent years, giving rise to the phytoremediation concept. Metal hyperaccumulating plants typically store large amounts of metals in their aerial parts, which renders hyperaccumulators highly suitable for phytoremediation. To exploit full potential of phytoremediation, it is obligatory to investigate the mechanisms responsible for tolerance and hyperaccumulation, using natural hyperaccumulators as model plant species. The use of local plant species for phytoremediation purposes is meaningful because these plants could survive under local environmental conditions of the area as compared to other plant species.

About 25% of hyperaccumulators identified so far recruit from the family *Brassicaceae*; other families rich in hyperaccumulators include *Asteraceae, Euphorbiaceae, Rubiaceae, Fabaceae, Scrophulariacea, Myrtaceae, Proteaceae, Caryophylaceae, Tiliaceae*, etc.(Rascio and Navari-Izzo, 2011).

Criteria of Plants suitable for Phytoextraction:

In order to be suitable for phytoextraction purposes, plant species should meet the following criteria: (i) metallotolerance toward elements present in toxic levels, (ii) high biomass production and (iii) effective accumulation of heavy metal in easy-to-harvest parts. The overall concept of the restoration of polluted areas using phytoextraction consists of the cultivation of appropriate plant species *in situ*, harvesting the heavy metal containing biomass and treating it to decrease its volume and weight (by composting, compacting, drying, thermal decomposition). The resultant heavy matal enriched mass containing high levels of metal contaminants is subsequently disposed of as a hazardous waste or, if economically advantageous, can be utilized for the re-extraction of trace elements. In general, three basic strategies can be considered for heavy metal phytoextraction, differing in the type of plant species used: (i) natural hyperaccumulators, (ii) fast-growing plant species with high-biomass production, and (iii) genetically engineered plants.

Mechanisms involved in Phytoextraction:

Several crucial physiological steps of heavy metal detoxification by the hyperaccumulator plants are - (i) boosted HM ions uptake from the rhizosphere across the root cell plasma membrane, (ii) reduced HM ions sequestration in root vacuoles, (iii) intensified HM ions loading into the xylem for transport to shoots, and (iv) stimulated HM ions influx across the leaf cell plasma membrane and (v) sequestration in the leaf vacuole. Nevertheless, a considerable contribution of cell wall components, especially low-methyle sterified pectins, in the sequestration of HM ions within a plant body has also been reported.

Advantages of Phytoextraction:

i. Owing to incineration, the volume of harvested plant biomass that requires disposal is dramatically reduced.
ii. In some cases, additional source of revenue can be obtained by extraction of metals from metal rich ash; so therefore, it can be used to offset the cost of remediation.
iii. Cheaper than most clean-up methods.
iv. In comparison to conventional methods which typically disrupt soil structure and productivity, phytoextraction is capable of remediating heavily metal contaminated soil without impairing the soil quality.

Limitations of Phytoextraction:

As this process relies solely on plants, the remediation time is relatively longer than other anthropogenic soil clean-up processes.

CONCLUSION:

To conclude, recent field studies have demonstrated that some hyperaccumulators meet the requirements for utilization in a real phytoextraction process, especially for their enormous heavy metal bioaccumulation rates being far higher than those of high-biomass non-hyperaccumulators including those from genus *Salix, Populus*, etc. With more effort put into more modern GM techniques, the performance of many plant taxa can be further improved and efficiently used for large-scale phytoextraction purposes in real locations.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Role of microorganisms in insects

Article id: 22859

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INTRODUCTION: Insects are the most successful organisms on Earth, part of this success is due to their ability to feed on a wide variety of diets. Many of these foods have nutritional deficiencies that, in part are supplied by microorganisms. Therefore, microorganisms affected the development and survival of insects during millions of years of evolution, either being a direct food source or providing new metabolic pathways, which allowed the spread of these organisms.

Microorganisms that inhabit insect guts can play important roles in the host's nutrition, development, resistance to pathogens and reproduction. Insect hosts have shown to be adversely affected by the removal of the microorganisms and the association is believed to be necessary for the normal development of the host. Loss of microorganisms often results in abnormal development and reduced survival of the insect host (Eutick *et al*., 1978).

Role of symbionts in insects

Aid in Nutrition: Provide the nutrients like Vitamins, essential amino acid, sterol and fix free nitrogen from air for the host

- ✓ Allow the insect to utilize the different host
- ✓ Sex-determination
- ✓ Break down harmful environmental compounds
- ✓ Protest against predators and parasites

Insect feeding on nutritionally poor diets and their associated symbiotic micro organisms

Type of food	Insect	Position in body	Type	Contribution to insect
Wood	Blattodea (*Cryptocersus*)	Hindgut	Flagellates	Cellulose digestion
	Isopteran (kalotermitide)	Hindgut	Bacteria	Nitrogen fixation
	Coleopteran (Anobiidae)	Midgut cecal Epitheliem	Yeasts	Essential aminoacids
Greenplants	Hymenoptera	Ectosymbionts	Fungus	Cellulose digestion
Phloem	Homoptera Aphididae Delphacidae	Haemocoel Haemocoel	Bacteria Bacteria Yeast	Amino acids Amino acids Sterols
Vertebrate blood	Phthiraptera (Anoplura)	Variable	Bacteria	B-vitamins
	Hemiptera (Cimicidae)	Haemocoel	Bacteria	B-vitamins
Detritus	Blattodea	Hindgut fatbody	Bacteria Bacteria	CHO digestion N2-recycling

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Effect of symbionts on reproduction

- ✓ In **German cockroach** the reproduction adversely affected if symbionts are removed
- ✓ The symbionts in *Rhodnius* have some influence in endocrine system of insect

Symbionts in Sex Determination:

- ✓ In **coccid of genus, *Stictococcus*** has been reported by **Bucchner**
- ✓ The symbionts invade ovary but associated with certain oocytes only

Two types of egg developed

1. With symbionts- Female eggs are produced
2. Witout symbionts- Male eggs are produced

Break down harmful environmental compounds

The fenitrothion degrading *Burkholderia* strains establish a specific and beneficial symbiosis with the stinkbugs, *Riptortus pedestris* and confer a resistance of the host insects against fenitrothion. Experimental applications of fenitrothion to field soils drastically enriched fenitrothion-degrading bacteria from undetectable levels to >80% of total culturable bacterial counts in the field soils, and >90% of stinkbugs reared with the enriched soil established symbiosis with fenitrothion-degrading *Burkholderia* (Kikuchi *et al.*, 2012).

Implications of insect symbiosis for control of agricultural pests

- ✓ Targeting the bacterial partner, mainly through the application of antibiotics
- ✓ By disrupting the symbionts transmission route to the next host generation
- ✓ Use of antimicrobial peptides (AMPs) as a tool to control bacterial populations

CONCLUSION: Investigations on the microbial community associated with insects revealed that the biology of these insects is profoundly influenced by the microorganisms they harbour. Recent studies continue to uncover an ever growing number of ways by which insects exploit the microorganisms, including their capacity to digest cellulose. The baseline information about insect-microorganism symbiosis provides opportunities for novel pest management strategies.

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Urea-Molasses Mineral Blocks (Buffalo Chocolates) Supplementation in the Ration of Dairy Animals

Article id: 22860

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INTRODUCTION

Milk production in India was estimated at 187 million tonnes per annum at the end of 2019, and growth in production has been about 6 percent. Indian milk production comes from buffalo milk (54 percent), cow milk (42 percent) and the balance (4 percent) is from small ruminants (sheep and goats). The basis for Indian milk production is the millions of nondescript and crossbred cows and buffaloes in rural areas, fed mainly on crop residues and agro-industrial by-products. The mainstay of the feeding system in India is fibrous feed, which forms the bulk of ruminant diets. These fibrous feeds are deficient in protein, energy and minerals, with poor palatability and digestibility. Without additional supplements, such feeds can not support even body maintenance of the animals. One of the methods of increasing utilization of straws is the supplementation of deficient nutrients in the form of fermentable N, energy and minerals, ensuring thereby enhanced microbial growth in the rumen, which in turn enables the ruminants to consume more straw. In India the National Dairy Development Board (NDDB), Anand first introduced farmers to UMMBs in 1983, when they were prepared by using a "hot process" technique and has popularized the blocks, they are called **'Buffalo Chocolates'**.

Why the blocks?

Urea molasses mineral block is prepared by mixing urea, molasses, mineral mixture and other ingredients in a suitable proportion. It is a readily available source of energy, protein and minerals for the dairy animal. Supplementing an animal with UMMB would provide adequate quantity of these nutrients and slow ingestion of urea leads to efficient microbial protein production and improved digestibility. NDDB has developed 'cold process' of manufacturing UMMB licks (3 kg blocks) and the technology is being provided to dairy cooperatives, private organizations and other agencies. UMMB is very useful for milk producers in green fodder deficit areas.

Production aspects of UMMB technology

Acceptance of any product greatly depends upon its manufacturing process, cost of production, shelf life, convenience of use, etc. Various problems in production were encountered when UMMB technology was first introduced, affecting acceptance by farmers. NDDB spent a substantial amount of time and money in standardizing UMMB production technology, to ensure that the product is in presentable form. For the benefit of institutions and individuals engaged in the production of UMMB, experiences with UMMB production at different times and stages is described below.

The hot process

The ingredients used for the production of blocks by the hot process are given in Table 1. These were produced by steam heating molasses mixed with other ingredients, in a double-jacketed insulated vessel. After heating for 150 to 180 minutes at 130°C, the material was removed from the vessel, weighed in aliquots of 3 kg, put into moulds and allowed to harden. Although these hot process blocks were distributed to farmers for nearly ten years, they were never used regularly. This was probably due to inefficient extension and marketing, coupled with costs, which quadrupled between 1983 and 1993, in contrast to the price of feed concentrates, which only doubled over the same period.

Other related problems included the high cost of plant maintenance and fuel, unreliable equipment with frequent breakdowns, high labour demands and the difficulties of manually weighing the hot material. The blocks were also highly hygroscopic: at 60 percent relative humidity, blocks would deliquesce in storage and form a liquid mass.

Table 1: Composition of hot process UMMB lick blocks (by weight).

S.N.	Ingredient	percentage
1.	Urea	15
2.	Molasses	45
3.	Mineral mixture	10
4.	Calcite powder	8
5.	Sodium bentonite	3
6.	Cottonseed meal	15
7.	Common salt	4

Source: Garg, Mehta and Singh, 1998.
Size = 245 x 150 x 65 mm.
Weight = 3 kg.

The cold process

In view of problems faced in manufacturing the block licks by the 'hot process', efforts were made to produce blocks by the 'cold process' using lime as a gelling agent. It was possible to produce reasonably-hard blocks using lime, however these blocks had very low palatability due to their bitter taste, resulting in poor acceptance at the field level. The ingredients used for the production of blocks by the hot process are given in Table 2.

Table 2: Cold process UMMB lick formulation.

S.N.	Ingredient	percentage
1.	Urea	6
2.	Molasses	45
3.	Mineral mixture	6
4.	De-oiled rice bran	14
5.	Rice pollard (fine)	13
6.	Calcite oxide	4
7.	Magnesium oxide	2
8.	Phosphate buffer	10

The "cold process" developed by dairy board (NDDB) of India

Efforts were made to improve the block lick formulation, to ensure that the blocks were hard enough and also palatable to the animals. To achieve this, lime and magnesium oxide were used in combination, and a buffering agent was added towards the end of the process to reduce the pH which considerably improved palatability of the blocks. In addition to modifying the formulation and the production process, Dairy board also designed a plant for manufacturing the blocks and a dispenser for feeding blocks (Photos 1 and 2).

Fig. 1. UMMB plant with pneumatically controlled rotary pressing device for UMMB feeding to animals.

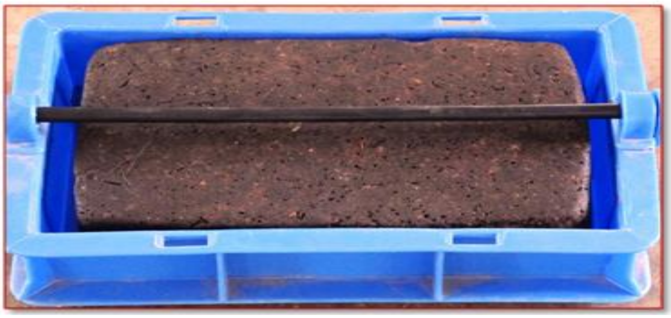

Fig. 2. A plastic trough for UMMB feeding to animals.

Packaging of Blocks

Since block licks are hygroscopic, proper packaging is very important and should be moisture proof to maintain the quality of the blocks. Bags made of different materials were evaluated; they included polythene sheet, multifilm (low density/high density), PET laminate film (aluminium foil/PET film/polythene sheet) and high molecular weight high density (HMHD) sheet. Considering their cost, sturdiness and impermeability, HMHD bags were found be the most reliable.

Advantages of feeding UMMB licks to animals

- Stimulates rumen fermentation, thereby, increases straw intake by animals.
- Increases microbial protein synthesis and supply at abomasum level, giving higher productivity.
- Improves daily milk (by 0.5–1.0 kg) and fat (by 0.3–0.5 percent) yields.
- Increases lactation length. Maintains health and reproductive functions.
- Improves growth rate of animals on straw-based diets.
- No risk of urea toxicity.

Factors affecting UMMB licking by animals

- Level and type of concentrate supplementation.
- Level and type of basal ration, which includes leguminous and nonleguminous green fodder and dry fodder such as crop residues or hay.
- Type of animal (species and breed.
- Physiological stage, such as growth, lactation or non-lactation (dry).
- Method of dispensing UMMBs.
- Extent of availability of UMMBs.
- UMMB hardness.

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Points to be remembered for maximizing gain from UMMB feeding

- Dispense the UMMB in front of the animal in a proper way.
- Initially, the licking of UMMB by Zebu cattle and buffalo will be slow.
- Needs an adaptation period of 1–2 weeks.
- Do not discontinue the block.
- Use the block as a lick only.
- Do not spray water on the block for licking.
- The UMMB lick should be protected from dung, urine, fodder and rain.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

The physiological seed enhancement techniques

Article id: 22861

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The seed is a basic input in agriculture. Quality of seed can be deteriorated due to many reasons as environmental conditions not favourable at the time of seed formation, mishandling during harvesting, processing and storage and unsuitable storage conditions with high moisture and temperature which increases seed ageing. The quality of the seed can be improved by the seed enhancement technique. One such technique is seed priming which could improve seed germination and germination synchrony in plants. This article gives an overview of the different priming techniques.

INTRODUCTION

Seed Quality Enhancement Defined as Post-harvest treatment that improve germination or seedling growth or facilitate the delivery of seeds and other materials required at the time of sowing. Although seed quality is governed by genetic make-up, the quality of seeds may deteriorate in subsequent stages like harvesting, threshing, processing and storage period. Retention of seed germination always forms an important consideration in agricultural practices. The poor seed-handling condition gives rise to deterioration of seed quality and results in the loss of viability. Also, this greatly affects seed vigor, which ultimately gives a poor performance in the field and the seed is not able to meet the quality standards prescribed for that crop. Hence, some physical and chemical operations are performed with the seeds between processing to storage time to overcome these problems. One such technique is priming. Seed priming is the physiological enhancement technique by which controlling the hydration level within the seeds so that the metabolic activity necessary for germination could occur but radical emergence is prevented.

Seed enhancement improves hygiene and mechanical properties, breaking of dormancy, synchronize germination, apply of nutrients and impart stress tolerance. Physiological seed enhancement techniques have been categorized into the following ways

[A] Pre-hydration:-

Seed hydration is the process of soaking seeds in water or dilute solution of growth-regulating compounds to induce early germination, better root growth, and seedling growth and also enhances the yield potential of the crop variety. It is of two types:-

1) Seed fortification- It is a pre hydration technique where seeds are soaked either in water or dilute solution of bioactive chemicals such as micronutrients, growth regulators, vitamins and seed protectants.
2) Seed infusion- It is a method of impregnation of seeds with bioactive chemicals through organic solvents instead of water this technique of infusion which helps to avoid the damage caused to the seed due to soaking in water. Hence this method is highly suitable to the seeds that suffer from soaking or seed coat injury (pulses).

[B] Priming:-

It is based on the principle of controlled Imbibitions, to a level that permits pre germination metabolism to proceed, but prevents the actual emergence of radicals. It is of following types

1) Hydro priming (drum priming)- It is achieved by continuous or successive addition of a limited amount of water to the seeds. A drum is used for this purpose and the water can also be applied by humid air. 'On-farm steeping' is the cheep and useful technique that is practiced by incubating seeds (cereals, legumes) for a limited time in warm water.
2) Halo priming-Halo priming involves the use of salts of chlorides, sulphates, nitrates, etc. This priming makes seeds to improve their performance under salt-stressed conditions.
3) Bio priming- It is a process of a biological seed treatment that refers to a combination of seed hydration (the physiological aspect of disease control) and inoculation (the biological aspect of the disease control) of seed with beneficial organism to protect seed with the help of beneficial fungi and bacteria.
4) Osmo conditioning – Osmo conditioning is the standard priming technique. Seeds are incubated in well-aerated solutions with a low water potential and afterward washes and dried. The low water potential of the solutions can be achieved by adding osmotica like mannitol, polyethyleneglycol (PEG), etc.
5) Solid Matrix Priming or Matri conditioning - It is the incubation of seeds in a solid, insoluble matrix with a limited amount of water. This method confers slow imbibition. Matric carriers are Calcinated clay, Vermiculite, Peat Moss, Sand, Micro-Gel, etc.

CONCLUSION

The productions and timely supply of quality seeds to the farmers are most crucial and challenge the technology. Good quality seed acts as a catalyst for realizing the potential of all other inputs in agriculture. Without good seed, the investment in fertilizers, water, pesticides, and other inputs will not pay the desired dividends. Therefore, the production of quality seed and maintenance of high germination is of utmost significance in the seed program. In this way, seed enhancements technology has a core objective that plays a significant role in improvising seed performance.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Principles of Organic Agriculture

Article id: 22862

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INTRODUCTION:

According to the Food and Agriculture Organization (FAO), "sustainable agriculture is the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of environment and conserving natural resources". All definitions of sustainable agriculture lay great emphasis on maintaining an agriculture growth rate, which can meet the demand for food of all living things without draining the basic resources. Organic farming is one of the several approaches found to meet the objectives of sustainable agriculture. Organic farming is often associated directly with, "Sustainable farming." However, 'organic farming' and 'sustainable farming', policy and ethics-wise are two different terms. The International Federation for Organic Agriculture Movement's (IFOAM) definition of organic agriculture is based on:

1. The principle of health
2. The principle of ecology
3. The principle of fairness and
4. The principle of care

Each principle is articulated through a statement followed by an explanation. The principles are to be used as a whole. They are composed as ethical principles to inspire action.

1. Principle of health:

Organic Agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible. This principle points out that the health of individuals and communities cannot be separated from the health of ecosystems - healthy soils produce healthy crops that foster the health of animals and people. Health is the wholeness and integrity of living systems. It is not simply the absence of illness, but the maintenance of physical, mental, social and ecological well-being. Immunity, resilience and regeneration are key characteristics of health. The role of organic agriculture, whether in farming, processing, distribution, or consumption, is to sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings. In particular, organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being. In view of this it should avoid the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects.

2. Principle of ecology:

Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them. This principle roots organic agriculture within living ecological systems. It states that production is to be based on ecological processes, and recycling. Nourishment and well-being are achieved through the ecology of the specific production environment. For example, in the case of crops this is the living soil; for animals it is the farm ecosystem; for fish and marine organisms, the aquatic environment. Organic farming, pastoral and wild harvest systems should fit the cycles and ecological balances in nature. These cycles are universal but their operation is site-specific. Organic management must be adapted to local conditions, ecology, culture and scale. Inputs should be reduced

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by reuse, recycling and efficient management of materials and energy in order to maintain and improve environmental quality and conserve resources. Organic agriculture should attain ecological balance through the design of farming systems, establishment of habitats and maintenance of genetic and agricultural diversity. Those who produce, process, trade, or consume organic products should protect and benefit the common environment including landscapes, climate, habitats, biodiversity, air and water.

3. Principle of fairness Organic:

Agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities. Fairness is characterized by equity, respect, justice and stewardship of the shared world, both among people and in their relations to other living beings. This principle emphasizes that those involved in organic agriculture should conduct human relationships in a manner that ensures fairness at all levels and to all parties - farmers, workers, processors, distributors, traders and consumers. Organic agriculture should provide everyone involved with a good quality of life, and contribute to food sovereignty and reduction of poverty. It aims to produce a sufficient supply of good quality food and other products. This principle insists that animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behavior and wellbeing. Natural and environmental resources that are used for production and consumption should be managed in a way that is socially and ecologically just and should be held in trust for future generations. Fairness requires systems of production, distribution and trade that are open and equitable and account for real environmental and social costs.

4. Principle of care Organic:

Agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment. Organic agriculture is a living and dynamic system that responds to internal and external demands and conditions. Practitioners of organic agriculture can enhance efficiency and increase productivity, but this should not be at the risk of jeopardizing health and well-being. Consequently, new technologies need to be assessed and existing methods reviewed. Given the incomplete understanding of ecosystems and agriculture, care must be taken. This principle states that precaution and responsibility are the key concerns in management, development and technology choices in organic agriculture. Science is necessary to ensure that organic agriculture is healthy, safe and ecologically sound. However, scientific knowledge alone is not sufficient. Practical experience, accumulated wisdom and traditional and indigenous knowledge offer valid solutions, tested by time. Organic agriculture should prevent significant risks by adopting appropriate technologies and rejecting unpredictable ones, such as genetic engineering. Decisions should reflect the values and needs of all who might be affected, through transparent and participatory processes. In totality organic agriculture aims at a sustainable production system based on natural processes.

Characteristic Features of Organic Agriculture:

- It relies primarily on local, renewable resources.
- Makes efficient use of solar energy and the production potential of biological systems.
- Maintains the soil health and fertility.
- Maximizes recycling of plant nutrients and organic matter.
- Does not use organisms or substances foreign to nature (e.g. GMOs, chemical fertilizers or pesticides).
- Maintains agro-biodiversity.
- Gives farm animals life conditions that correspond to their ecological role and allow them a natural behaviour.

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Organic agriculture is also a sustainable and environmentally friendly production method, which has particular advantages for small-scale farmers. Available evidence indicates the appropriateness of organic agriculture for small farmers in developing countries like India. Organic agriculture contributes to poverty alleviation and food security by a combination of many features, such as;

- Increasing yields in low-input areas.
- Conserving bio-diversity and nature resources on the farm and in the surrounding area.
- Increasing income and/or reducing costs.
- Producing safe and varied food.
- Being sustainable in the long term.

The evaluations by IFAD in India and China (Giovannucci, 2005) reported that the income of participating farmers can increase substantially by adopting organic practices of farming. Certified production gives access to a premium market, or simply just better market access.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Polyploidy: a novel technique for improvement of vegetable crops

Article id: 22863

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Polyploidy refers to the presence of more than two complete sets of chromosomes per cell nucleus and such organism is known as polyploid. In nature, it ranges from 35% (Stebbins, 1971) to 70% (Masterson, 1994) in angiosperms. It is responsible for increasing genetic diversity and producing species with increased size, vigour and resistance to diseases. Thus, the production and application of polyploidy breeding have brought remarkable economic and social benefits (Can, 2012).

TYPES OF POLYPLOIDY

I. Types based on origin

A. Naturally occurring- Produced due to mutation in gene which codes for the spindle forming protein during cell division, or due to the production of unreduced gametes.

B. Induced- Induced by application of colchicines @ 0.01-0.5% (or other chemicals like acenapthane chloralhydrate, sulphanilamide, ethylmercury chloride, colchamine, oryzalin, trifluralin etc) which dissolves the spindle fibber during cell division and results in chromosome doubling. Blackslee and Avery (1937) first showed method of induction in Portulaca and Datura plants by application of alkaloid colchicines (isolated from autumn crocus plant, *Colchicum autumnale*).

II. TYPES BASED ON GENOME CONTENT

A. **Auto-polyploids-** Multiple chromosome sets derived from a single species and can arise from a spontaneous genome doubling (eg. potato) or fusion of 2n gametes.

B. **Allo-polyploids-** Multiple chromosomes derived from different species and they are result of multiplying the chromosome number in an F_1 hybrid.

ADVANTAGES OF POLYPLOID ORGANISMS

The advantages of polyploids are heterosis and gene redundancy. Heterosis causes the polyploids to become more vigourous than their progenitors, whereas, gene redundancy shields polyploids from the deleterious effects of mutation in one or more vital genes.

APPLICATION OF COLCHICINE

A. **Seed treatment:** Imbibed and germinating seeds can be treated with 0.01 to 0.8 % colchicine in solution or in agar media for 3-4 hours. Followed in plants, which become large and woody within few days after germination due to faster growth rate.
B. **Immersion method:** Flexible twigs are kept immersed in 0.25 % colchicine solution for one day.

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C. **Mixtures with lanolin:** Mixtures with lanolin have been successfully used in inducing 4n tissue but considerably higher concentration of solution is needed.
D. **Covering the bud with cotton:** The solution is soaked in a piece of cotton and the target bud is kept covered with that cotton. This is most commonly used method.
E. **Capillary string method** A string is immersed in solution and the other end wrapped around the bud and the colchicine solution moves by capillary action.
F. **Single drop application:** A single drop of colchicine solution is applied on the target bud and repeated several times. It is more economical as very less solution is needed.

DETECTION OF HIGHER PLOIDY LEVEL

Conventionally ploidy levels are determined by counting the chromosomes of meristematic tissue (i.e. root tips at metaphase phase of cell division) from individual plants. However to screen large number of plants requires trained skills, labour intensive, time and resource consuming as well. Among the several alternative and indirect methods of ploidy determination, the following one are generally employed-

a. **Counting chloroplast number in the stomatal guard cell:** positive correlation exists between the number of chloroplast in the guard cell and the ploidy level in many plant species.
b. **Measuring stomatal length:** Length of the stomata is measured under ocular microscope. Longer the stomata, higher the ploidy within the same species.
c. **Measuring pollen grain diameter:** plants having higher ploidy levels produce larger pollen grains.
d. **Flow cytometry:** It is a method of measuring nuclear DNA content in plants. It more accurate than the above three methods. However, this method requires the use of expensive equipments.

Polyploid varieties released in vegetable crops and their salient features

Variety	Crop	Salient features
Sree Harsha	Cassava	Triploid, stout non branching plants, yields 35-40 t/ha and contains starch 39.05%
Pusa Jyoti	Palak	Tetraploid, very big, thick, tender, succulent dark green leaves, quick rejuvenation, yields 50 t/ha
Arka Madhura	Watermelon	Triploid seedless, TSS 13-14 %, longer shelf life and transport quality, suitable for year round production under protected condition, yields 50-60 t/ ha
Pusa Bedana	Watermelon	Seedless triploid hybrid having aborted embryos and false, rudimentary, least perceptible seeds.

PLOIDY MANIPULATION IN VEGETABLE CROPS

Triploid Watermelon (3x = 33)

Triploid seedless watermelons were first produced by Dr. Kihara who started the experiment by treating a normal diploid (2x = 22) plant with colchicine to obtain a tetraploid from (4x = 44), and then used the pollen of the diploid to pollinate the stigma of the induced tetraploid, producing the triploid progeny (Crow, 1994). Since the triploids were infertile, they did not produce sufficient viable pollen for pollination and fruit development. Consequently, diploid plants were planted in the same area of the

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triploids to supply the required pollen for seedless fruit production (Crow 1994). Seedless watermelons are popular in Israel, Japan and the Northern territory in Australia. In India, it is slowly gaining popularity among the consumers.

Triploid Sugar Beet (*Beta vulgaris* L.; 3x = 27)

Sugar beet is a crop of major importance for sugar production in temperate areas, and exists in diploid (2x = 18), triploid (3x = 27) and tetraploid (4x = 36) forms (Smulders et al. 2010). Since the 1970s, most of the sugar beet varieties are the synthetic triploid forms, which are cultivated mainly in Europe and in the United States. Triploid sugar beets are produced by crossing male diploid sterile plants with tetraploid pollinators or by reciprocal crossing, i.e., between male tetraploid sterile plants and diploid pollinators (Kinoshita and Takahashi 1969). Triploid sugar beets have larger roots than diploid ones, but maintain the same sugar content of the diploids and thus yield more sugar per unit area. Moreover, triploid sugar beets are highly sterile and do not produce seeds, which is not a disadvantage, since only their roots are relevant for commercial purposes (Dabholkar 2006).

Polyploid Onion

McCallum (1988) treated F_1 of *Allium cepa* × *Allium fistulosum* and reciprocal crosses with colchicines and recorded C_2 population with good seedling vigour and winter hardiness at Beltsville during the winter as compared to normal diploids.

Polyploid Asparagus

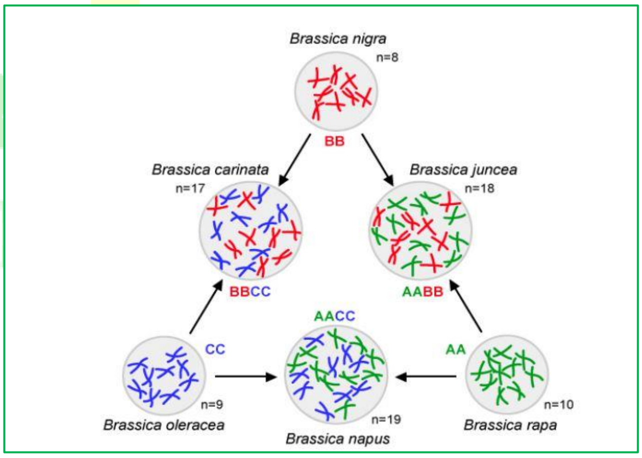
Sheidai and Inamdar (1992) studied meiosis in distinct polyploid species of *Asparagus*. The tetraploid species (*n* =20) *A. racemosus* var. *javanica*, *A. densiflorus* cv. Myers, *A. racemosus* var. *subacerosa* and hexaploid species (*n* = 30). *A. gonoclados* recorded high pollen fertility and fruit set. This was due to regular disjunction of chromosomes at anaphase. Further, the tetraploid species had larger pollen grains than diploids.

Polyploidy in the Genus *Brassica* L.

Nagaheru (1925) proposed the evolution theory of natural-amphidiploid *Brassica* species from three diploid species.

Alteration of ploidy for overcoming fertilization barrier in distant crosses

In order to transfer desirable genes from wild species to cultivated species, a breeder has to go for the wide inter specific crosses. These crosses often fails either due to either pre or post fertilization barrier. In the post fertilization barrier, when the resultant F_1 is sterile due to mismatch of the chromosome counterparts, further backcrosses cannot be made with the recurrent parent. Doubling the chromosomes of F_1 plant helps to recover the fertility and further backcrosses can easily be made. In case of pre-fertilization barrier, the pollen grains fail to



germinate on the stigma and if it is germinated, pollen tube fails to reach the ovary to form the viable zygote. In this case, doubling the chromosomes of the female parent allows the proper pollen tube growth and viable zygote formation subsequently.

CONCLUSION

- ✓ Polyploidy generally results into gigantism in plants. More beneficial for those crops like potato, sweet potato, taro, yam and the leafy vegetables where vegetative parts are consumed.
- ✓ Natural polyploids in potato and sweet potato helped to increase the storage organs and became the major source of starch worldwide.
- ✓ Production of Doubled Haploid (DH) plants reduced the breeding cycle as well as helped the breeders to generate F_2 mapping population in crops like carrot and onion which show very high rate of inbreeding depression.
- ✓ Diplotization of the chromosomes helped to overcome fertilization barriers with distantly related species.
- ✓ Seedlesness is achieved in watermelon through triploidy.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Lac based intercropping system as carbon sink for climate change mitigation option in India

Article id: 22864

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INTRODUCTION

In recent times climate change has been identified as one of the most complex issues facing by the human causing several natural catastrophic climatic impacts. The planet's average surface temperature has risen 0.85°C during the period 1880-2012 (IPCC, 2014), a change driven largely by increased carbon dioxide and other human-made emissions into the atmosphere and it is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate (IPCC, 2018). Scientists have reported many consequences of climate change each year, and many agree that economic, environmental and health consequences are likely to occur if current trends continue. And experts see that the trend is accelerating over the past 50 years. Forest plays a vital role in mitigating the diverse effects of environmental degradation and acting as a carbon sink of the terrestrial ecosystem. Trees and forest have an essential and central role to limit the rise in atmospheric carbon and slow down the climate change through sequestration and storage of atmospheric carbon.

Role of NTFPs in ameliorating environment

India is the fourth highest emitter of carbon dioxide in the world (Friedlingstein *et. al*., 2019). The emission is expected to grow every year pushed by economic growth. The change in land-use system for developmental activities and conversion of forest into agricultural land are the major sources for loss of forest area in India. Resource utilization and environment protection are always two contradicting processes in the context of development. However, NTFPs (Non Timber Forest Products) has been recognized as an important element for sustainable forest management and economic development. It constitutes an important source of livelihood for forest fringe communities across the world. It has been increasingly recognising its contribution to food security, diversified income sources and ecosystem services. The most promising contribution of NTFPs which has recently become important is the storage of carbon within trees. Trees are composed of approximately 50% carbon and, therefore they act as reservoirs for carbon storage if they remain in solid form (Sarkar and Manoharan, 2009). Lac is one of the important NTFPs for forest dweller of India having high market value globally. India has large lac host resources which can fulfil the demand for economic sustainability and climate change mitigation.

Lac is a natural resin of animal origin secreted from Lac insect belonging to family Tachardiidae (=Kerriidae). Indian lac insect (*Kerria lacca*) is the most widely exploited insect for cultivation. It has a wide range of applications in varnishes, paints, food, cosmetics, pharmaceuticals, perfumes, polishes, adhesives, jewellery and textile dye. Lac is mainly produced in India, Myanmar, Malaysia, Thailand, Lao, Yuan province of China, Taiwan, Philippines, Vietnam, Cambodia and Sri Lanka. Among them, India is the largest producer, processor and exporter of the lac in the world with a production of 18746 tons and shares 1.99% of total NRG (Natural Resins and Gums) production in India (Yogi *et. al*., 2018). Jharkhand, Bihar, West Bengal, Madhya Pradesh, Chattisgarh, Eastern Maharashtra and northern Orissa are the major lac producers in India and over 90% of lac produce comes from these states. The two strains of *K. lacca i.e*., Kusmi and Rangeeni, are commercially exploited in India (Kapur, 1962; Ramani, 2005).

Distribution of lac insect

Lac insects are restricted to tropical and sub-tropical regions of the world and are distributed in the region lies between 60^{o} West to 125^{o} East longitude and 37.5^{o} North to 7.5^{o} South latitude (Srivastava, 2011). In India, lac is found in the forest of Himalaya Tarai, hilly regions of Jharkhand, Chattisgarh, West Bengal, Orissa, Madhya Pradesh, Utter Pradesh, some pockets of Deccan plateau, Rajasthan, Gujarat and Assam (Srivastava, 2011).

Lac host plant and their distribution

The major host plants include fourteen species in which *Kusum* (*Schleichera oleosa*), *Palas* (*Butea monosperma*), and Ber (*Ziziphus mauritiana*) are the excellent host in India. In addition to these host plants, *Flemingia semialata* and *F. macrophylla* are the emerging host plants which found to be economically suitable. In India, the number of host plants recorded for Indian Lac insect is 129 and out of which 19 host plants are of good quality and commercially important (Sharma, 2017). Lac host plants of Indian Lac insect and their distribution which are of commercial and specific importance is shown in table 1.

Table 1: Lac host plant of commercial and specific importance and their distribution

Host plant	Common name	Distribution
Butea monosperma	*Palas*	All over India
Schleichera oleosa	*Kusum*	All over India
Zizyphus mauritiana	Ber	All over India
Flemingia semialata	Van chhola/Semialata	All over India
Flemingia macrophylla	Bhalia	All over India

(Source: Sharma, 2017; Kumar and Kumar, 2013)

Lac based Intercropping system as carbon sink

In the lac growing states of India, the forest dwellers living in the forest and forest fringe traditionally cultivate the lac year-round. They are cultivating lac majorly in the forest and also in their farmland. More than 75% of tribal farmers are engaged in lac cultivation and it contributes a major part of their livelihood (Das and Kumar, 2013). In recent times, in order to assure an integrated source of income, the forest dwellers are cultivating lac along with seasonal vegetable crops. They are growing vegetable crops under *Palas*, Ber, *Kusum* and Semialata. Nowadays, most of the tribal farmers prefer Semialata, a shrubby leguminous plant to intercrop with vegetable crops as it is fast growing, possess short stature, satisfactory coppicing response and can inoculate lac after one year of plantation. There are well established and successful of such system in farmer's field, which are being followed since time immemorial. One such example is rice field bunds surrounded with *Palas* trees in Madhya Pradesh and Chattisgarh. There are possibilities to explore utilization of gaps between rows of *Palas, Kusum* and Ber. Since the spacing requirement is different for different host and type, the proportion of intercrop will be different. Shade loving crops like turmeric, elephant yam, ginger etc., may be tried. Many studies have been reported that the farmers are getting benefits from such intercropping system in lac growing areas. Intercropping system can improve the crop yield and productivity considerably. It also provides certain environmental benefits and enriches the soil. There are many studies applying intercropping system to improve the income of the farmers and optimizing environmental stability. As such Lac based intercropping system not only improves the resilience of rural livelihood but also encourage environmental stability. This can provide a great potential of carbon sink in cropland for reducing the atmospheric concentration of CO_2 for mitigating climate change. Bhatt, 2016 reported that total carbon stock under Ber, *Palas* and *Kusum* plantation was 17552 kg/ha, 18816.93 kg/ha and 36573.55 kg/ ha, respectively. In Semialata plantation above ground biomass was 3166.66 kg/ha, which corresponds to 1583.33 kg carbon per hectare and below ground biomass was 5559 kg/ha, equivalent to 2229.6 kg carbon per hectare (Bhatt, 2017). However, the information on carbon stock under Lac based intercropping system is lacking. It has huge potential to provide significant mitigation options but they require proper quantification of carbon sink in the system. Thus, Lac based intercropping system creates carbon sink while enhancing the rural livelihood of lac growers.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Antioxidants: Super Chemicals

Article id: 22865

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INTRODUCTION

Changing lifestyles have resulted in a great change in the health status of the human population. Sedentary lifestyle, inadequate diet and stress have increased the onset of degenerative diseases like cardiovascular diseases, diabetes mellitus, cancer and arthritis. Free radical generation becomes the pathway by which the causative factors promote the diseases in the human system. A free radical is defined as any molecular species that contains an unpaired electron and attacking the nearest stable molecules and abstracting its electron to attain stability (Lobo *et al* 2010). The free radicals are highly reactive chemical species such as hydroxyl radical, superoxide anion radical, oxygen singlet, hydrogen peroxide, nitric oxide radical, hypochlorite and peroxynitrite radicals that travel around the body and causes damage to biologically relevant molecules such as DNA, proteins, carbohydrates, lipids and carbohydrates (Young and Woodside 2001).

The human body has a complex defense mechanism against free radicals. The innate oxidant defense system is not sufficient to deal with the number of free radicals produced during normal metabolic processes. When the balance between antioxidants and oxidants in the body is shifted by the overproduction of free radicals, it leads to oxidative stress and DNA damage. Low level of antioxidants along with inhibition of the antioxidant enzymes may lead to an imbalance between free radical production and antioxidant defense system thereby causing oxidative stress (Rock *et al* 1996). Oxidative stress plays a critical role in the pathogenesis of various degenerative diseases including atherosclerosis, ischemic heart disease, diabetes mellitus, cancer, neurodegenerative diseases and immune suppression (Souri *et al* 2008). The most effective way to remove oxidative stress causing free radicals is with the help of antioxidants.

Antioxidants

Antioxidants are the first line of defense against free radical damage and are significant for maintaining optimum health and well-being as reported by Percival (1998). An antioxidant acts as a radical scavenger, electron donor, hydrogen donor, singlet oxygen quencher, peroxide decomposer, an enzyme inhibitor, synergist and metal chelating agent.

Antioxidants present in the human diet are basically bioactive non-nutrient plant compounds having numerous biological effects that include anti-microbial, anti-inflammatory, antioxidant, vasodilatory and anti-cancer activities (Garcia *et al* 2005). An array of free radical scavenging antioxidants is derived from dietary sources like vegetables and fruits. Antioxidants, phytonutrients and bioactive components derived from plant sources are known to have a significant role in metabolism, physiology and disease regulation. Consumption of plant-derived phytochemicals from vegetables, fruits, and herbs may contribute to shift a balance towards an adequate antioxidant status (Halliwell 1994). Secondary plant metabolites such as flavonoids, polyphenols, carotenoids, isoflavones, isothiocyanates, indoles, saponins and terpenes are referred to as accessory health factors (Combs *et al* 1996).

Nutraceutical foods: Fruits and Vegetables

A variety of free radical scavenging antioxidants are derived from dietary sources like fruits and vegetables. Regular consumption of fruits and vegetables has always been associated with numerous health benefits. There is a significant and positive association between consumption of fruits and vegetables and reduced rate of heart disease mortality, common cancers and other degenerative diseases as well as aging (Dillard and German 2000). Vegetables contain a wide variety of biologically active, non-nutritive compounds known as phytochemicals. Phytochemicals in fruits and vegetables can have complementary and overlapping mechanisms of action which include scavenging of oxidative agents, stimulation of the immune system, regulation of gene expression in cell proliferation, hormone metabolism, apoptosis and antiviral and antibacterial effects as reported by Waladkhani and Clemens (1998). Apart from the phytochemicals, dietary fiber in vegetables also provides many health benefits. Water-soluble antioxidants such as ascorbic acid, phenolic compounds and polyphenols have been associated with an enhancement of the immune system and lower the risk of cancers while lipid-soluble components such as tocopherols and carotenoids have a protective role against cardiovascular and eye diseases (Cho *et al* 2007). Phytonutrients in vegetables such as carotenoids, glucosinolates, isothiocyanates, indoles, inositol phosphates, phenolic cyclic compounds, phytoestrogens, phytosterols, polyphenols, protease inhibitors, saponins, sulfides and thiols bring about a wide range of biological activities such as quenching of free radicals, modulation of enzyme activities, countering of degenerative processes, alteration of cellular functions and growth, cytotoxicity for tumor cells and alteration of bacterial activities (Bhaskarachary *et al* 2015).

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Tomato cultivation: Risk mitigation through improved technologies and value addition

Article id: 22866

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INTRODUCTION

Tomatoes are amongst the most widely grown crop in India and is animportant economic commodity of the eastern India. In eastern region, tomato is extensively cultivated in the vegetable belts covering the states of Bihar, Jharkhand, Eastern Uttar Pradesh, and West Bengal. In Jharkhand it occupies considerable area in the districts like Ranchi, Lohardaga, Hazaribagh and Godda and covers approximately 13.9% of the area under vegetable cultivation. There is considerable increase in area, production and productivity of tomato in Jharkhand owing to mild climate suitable for cultivation of tomato throughout year. At present, the estimated area and production under tomato in Jharkhand is 19460 ha and 226200 ton, respectively (NHB, 2017). Most of the produce is exported to the nearby states through organised trading network. This region is very conducive for off-season tomato production. There is also scope to further increase the productivity with the adoption of proper varieties, integrated nutrient management and cultivation of tomatoes on raised beds (Mali et al, 2016).
Over the past few years it has been observed that, during some years the aggregate tomato production from the state was so high that tomato prices fall below the threshold level where farmers even could meet the production expenses. On many occasions farmers fail to fetch reasonable price for their produce and there have been instances of dumping of tomatoes on roadsides or forgoing harvesting with ploughing of standing crop in the field. This has become more recurrent during past few years. This calls for suitable interventions to increase the economic returns during years of higher tomato production from the region.

As compared to national average (24.2 t/ha) the productivity of tomato in Jharkhand is 12.7 t/ha (NHB, 2017). The average tomato productivity in the region is lower mainly because of poor management practices and lack of technological innovation. The major causal factor for the situation of excess tomato production is cultivation of tomato by large number of farmers on wider areas. There is need to develop alternate strategies to address twin situation of low productivity and reduced prices. This calls for introduction of suitable technological interventions and capacity building of farmers not only in tomato cultivation but also in processing and value addition of tomatoes. This will help in handling the situations of over production or price decline. This study aimed at demonstrating suitable pathways for realising potential yields, taping the markets and value addition of tomato.

Study area

This study was carried out at Palna and Bhuiyadih villages of Tamar block of Ranchi district.Bhuiyadih is a tribal village located in the Tamar block of Ranchi district. Traditional cultivation practices were the mainstay of the agriculture in the village which led the crop production into a precarious state, affecting the livelihood of the farming community. Limited

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

access to technology, poor quality of agricultural inputs and confined knowledge about crop cultivation were major constraints in realising potential agricultural returns. Palna is a small and backward village located in the Tamar block of Ranchi district where vegetable cultivation is a prime source of livelihood and income. Once in every few years the villagers encounter a drop in procurement price of tomatoes, affecting the livelihood of the farming community. Lack of technical knowhow about preservation and processing of vegetables leaves them with little options other than throwing away the produce or selling off at throwaway prices. This kind of recurrent incidences has forced farmers to abandon tomato cultivation temporarily that to with huge economic losses. It was felt that proper mechanism for economic use of the unsold farm produce is the need of hour. Post processing and value addition can be the viable alternatives to make profitable use of unsold produce.

The approach

Preliminary surveys and interactions with farmers highlighted the problems faced by the farming community. Among others, losses to tomato crop on account of biotic and abiotic factors were the most prominent ones. Problems were faced right from nursery raising to post harvest handling of the produce. The study involved a two stage approach. In first stage, improved cultivation practices were demonstrated at the farmers' field while in second stage the practices of value addition in tomato for conversion of tomatoes to processed product were demonstrated. The improved practices of healthy nursery raising in plastic plug trays, drenching of nursery with fungicides for preventing damping-off of seedlings, lime application to control the soil acidity and use of stakes in rainy season tomato crop were demonstrated.

Intial discussions with farming community and rapo building

Keeping in view the fact that crop protection is also major issue in tomato, the farmers were trained on selection of problem specific plant protection chemicals and informed about right stage as well as the optimum doses to be applied. In order to catch up with distant markets, a strategy of selection of varieties with special qualities suitable for long distance transportation was adopted. Many diagnostic field walks were held within the villages during which farmers had the opportunity to pose relevant questions pertaining to the tomato cultivation. The experts provided on-spot solutions to the identified problems and farmers kept the note of these real time farm advisory.

Realizing the hard-pressing need of making economic use of the unsold farm tomatoes, the practice of ketchup making was demonstrated to the farming community. Processing the tomatoes to ketchup will not only minimize the economic loss during glut situation but will increase their income many folds. The project team demonstrated the practice of ketchup making to the farmers using a learning by doing approach. Farmers were first sensitized on the issues of losses incurred due to unsold produce and the possible alternatives with which they can effectively use the surplus produce. A group of students and farmers was trained in preprocessing of tomatoes, the ingredients and the process of ketchup preparation. The participants were given hands on training to do the different tasks so that each of them could get the feel and involve in the activity of value addition.

The Impact

Improved cultivation practices

Adoption of improved cultivation practices led to transformational change in the way tomato cultivation was perceived by the farmers. These practice improved the tomato yields considerably making it more economically viable venture. One of the farmers, Mr HaldharMahato experienced a very encouraging outcome. Tomato yield in his fields reached the level of 47 t/ha from a pre-intervention levels of about 28 t/ha over the period of three years. The farmers were of the opinion that reduced mortality of the seedling in nursery as well as in fields was the most notable factor that contributed to yield improvement. General improvement in crop vigour was observed which may be attributed to reduced soil acidity with the lime application. The intervention plot of Mr HaldharMahato also served as demonstration plot for other farmersof the village. Impressed by the conspicuous effects, other farmers are also adopting the improved practices demonstrated in Mr Mahato's fields. It was observed from the demonstration fields that improved cultivation practices can improve the income by 2 to 2.5 times. Proper linkage with state government officials is important to obtain latest information about government schemes for welfare of farmers.

Tomato crop in farmers fields

Value addition in tomato

At this point of time the villagers are equipped with technical know-how about the tomato processing and preservation. Now they are capable of to deal with glut situation and ward-off the probable loses under the scenario of over production and reduced market prices. Economic solutions to perceived problems are easily accepted by rural communities and they eagerly participate in the extension programs. Tomato ketchup is getting popular among rural population of the Jharkhand as well and it needs to be manufactured locally to reduce the transportation costs. Sincetomatoes are available practically throughout the year, there is scope for setting up small scale processing units across the villages. This will not only ensure efficient use tomatoes during the years of overproduction but will ensure proper remuneration to the farming community. Therefore, processing of tomatoes is a viable alternative in this region.Thripathi et al., (2017) showed that value added products of

Sensitization on processing of tomatoes

Participatory learning of value addition in tomato

tomato are women friendly and processing can increases gross profit by 22.95% and output of product per unit increases 8.33% over traditional practice

CONCLUSION

Given the context that the farming communities region lacks exposure to technological innovation, the improved cultivation practices can increase the income of farming families by 2.5 times. They miss-out on benefits of government schemes on account of lack of knowledge, therefore proper linkage with state government departments is important not only for empowerment of farmers but also for the success of these government schemes. Keeping in view the limited extension services in the remote villages, the approach of 'diagnostic field walk' was found to be an effective way of carrying out extension work among farmers. Solutions with clear economic impact to the problems faced by the farmers are easily accepted and in such situations they agree to participate in the extension programs.

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Applications of GNSS in Precision Agriculture

Article id: 22867

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INTRODUCTION:

Global Navigation Satellite Systems (GNSS) are fully functioning and commercially available to provide all guidance about the weather, virtually 24 hours a day anywhere on the earth's surface. GNSS are the collection of localization systems that use satellites to know the location of a user receiver in a global (Earth-centered) coordinate system and this has become the positioning system of choice for precision agriculture technologies. At present North American Positioning System known as Navigation by Satellite Timing and Ranging Global Position System (NAVSTAR GPS or simply GPS) and Russian Positioning System known as Globalnaya Navigatsionnaya Sputnikovaya Sistema or Global Navigation Satellite System (GLONASS) both qualify as GNSS. Two other satellite localization systems, Galileo (European Union) and Compass (Chinese), are expected to achieve full global coverage capability by 2020.

Applications of GNSS in Agriculture:

Satellite-based localization solutions have become quite mature and the GNSS receivers have found numerous applications in agriculture. These receivers are a key part of the precision agriculture technologies as position information is a prerequisite for site-specific crop management. However, not all tasks that need to be performed in precision agriculture need the same level of positioning accuracies. Some precision agriculture operations such as yield monitoring, soil sampling or variable rate applications, can be performed using submeter accuracy differential GPS (DGPS) as errors below 1 m are acceptable for these applications. Here, some of the specific applications of GNSS in Agriculture are mentioned below;

1. **Yield Monitoring:** Majority of precision agriculture practice adoption has occurred in grains, oilseeds and cotton. Cereal grain generally combines use physical sensors to measure grain flow (i.e. impact sensor), whereas, cotton yield monitors use microwave or near-infrared sensors to measure amount of cotton. GPS device is a key part of the yield monitor as position data is critical to determine spatial variability in crop yield.
2. **Compaction profile sensing:** Soil properties and environmental conditions are generally regarded as the main causes contributing to variability in crop yield within a field. The research conducted at the University of California Davis in a processing tomato field has indicated that variability in water infiltration rate caused by variability in soil compaction is a major factor affecting processing tomato yield. Soil compaction is often measured using an ASABE (American Society of Agricultural and Biological Engineers) standard cone

penetrometer (force per unit area of a penetrating standard cone known as cone index).

However, cone index (CI) is a point measurement that exhibits high variability, and is labour intensive and time consuming to measure if a huge amount of data needs to be obtained to map a large field. To overcome these limitations a compaction profile was developed. The device consists of five 5.1 cm long, active cutting elements that are directly connected to five octagonal load cells and can measure cutting resistance of soil directly ahead of the cutting elements.

3. **Tree planting site-specific fumigant application:** A major concern when one replaces an old orchard with a new one is the incidence of replant disease. For example, when young almond trees are planted at sites from where the old almond or stone fruit trees have been removed, the new plants get stunted or even get killed due to a poorly defined soil borne disease complex called replant disease. Although the exact cause of this disease is not well-understood, pre-plant, site-specific application of small amount of fumigant such as methyl bromide (MB), chloropicrin (CP), 1,3-Dichloropropane (1,3-D), or two-way mixtures of CP with MB or (1,3-D) can control the incidence of replant disease. Therefore, it is a common practice to apply fumigants to the soil over 2-4 m wide continuous strips centered over the future tree rows. However, manual tree planting-site-specific fumigant application is very labor intensive and handling of fumigants poses some risk. Accurately locating tree-planting site is a time consuming process. However, with the advent of high performance GPS (HPGPS), computer technology can be used to apply the right amount of fumigants at the right location.
4. **Real-Time Kinematics (RTK) GPS based plant mapping:** In recent years, application of centimeter accuracy RTK-GPS has received a lot of attention because of its ability to provide extremely precise location information. These highly precise RTK-GPS based systems, such as automated tractor steering systems, have become very popular in recent years. One such possibility is the ability to create a plant map using RTK-GPS by monitoring the seeds or transplants while they are being planted. Such a plant map can then be utilized for subsequent intra-row, weed-specific cultivation or chemical application.
5. **Precise weed management system:** Improved mechanical methods of weed control have been motivated by an increased consumer demand for organic produce, consumer and regulatory demands for a reduction in environmentally harmful herbicide use, and a decrease in the availability of farm workers willing to perform manual agricultural tasks such as hand weeding. Extensive research has been conducted to address this issue and alternate techniques have been developed to control weeds in the plant line (Evert *et al*., 2011). Since the RTK GPS based seed or transplant map was close to the actual plant map, it was hypothesized that a simple greenness sensor could be used to look for plants and when a plant is detected its coordinates could be compared with the coordinates of plants in the plant map. If there is no corresponding plant on the plant map, then it can be assumed to be a weed and an appropriate herbicide could be applied kill the weed. Such weed-specific chemical application can reduce the amount of chemical by 24-51% thus reducing cost and protecting the environment from the harmful effect of the chemical. Employing this principle, at University of Sevilla, designed and developed a fully automatic electro-hydraulic side-shift frame for row center positioning controlled by RTK GPS location

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

information to perform a precise mechanical (between row) and narrow herbicide band spray (over the crop row) weed control. This new system, equipped with RTK GPS technology, was used for targeted herbicide application to weeds along crop rows, without reducing the efficacy of the intra-row chemical control treatment, while providing savings of approximately 50% of herbicide. The savings in applied chemical not only reduced production costs but also reduced the environmental impact caused by the chemical. Moreover, use of this system led to reduction of labor required to hand weed on the average from 15.3 hours per hectare for the conventional treatment and 13.2 hours for the improved plant/weed specific treatment.

6. **Robotic applications:** The introduction of semiautomatic systems in combine harvesters a few decades back was one of the first steps towards automation. Today, full automatic, robotic systems have been incorporated into many different agricultural operations from harvesting to intelligent application of herbicides. These new systems in the agricultural sector present new challenges such as safety, user education and training, and machine actuation. Of these, safety is the most important as actuation often requires sensory information before mechanical execution. Robotic systems require sophisticated hardware and software in order to allow the adaptation to changing environments and accomplish exigent missions in a safe and efficient way. Two different approaches have become essential characteristic of intelligent vehicles system: combining local information with global localization to enhance autonomous navigation, and integrating inertial systems with GNSS for vehicle automation (Rovira *et al*., 2010).

Future Outlook:

The future application of GNSS in precision agriculture operations has no bounds. This type of agriculture, where the positioning along with additional data on the vehicle status, soil properties, crop health, and fertilizer requirements provide the knowledge base for decision making and management to improve productivity, safety, and quality while reducing cost and environmental impact. The central concept of precision agriculture is to apply only the inputs- what you need, where you need and when you need - and this can only be done if large amount of geo-referenced data are available to make informed management decisions.

Agricultural applications such as yield monitoring, plant mapping, precise weed management, etc. require many sensors to acquire data from the field, but these data can only be linked together through a map by means of the location information provided by the GPS or any other GNSS receiver. With this type of precision agriculture data, the prescriptions maps can be created for planning future farming tasks.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Biofloc Technology-A sustainable and ecological friendly approach for fish farming

Article id: 22868

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INTRODUCTION

Fishery and aquaculture sector across the world have played a tremendous role in ensuring food and nutritional security to the human mankind (FAO, 2017). The burgeoning human population have issued an undeniably demand for increasing the production from this sector. Moreover, the challenges and threats due to decrease in land and water resource availability have exaggerated the necessity for intensification of aquaculture activities to meet the rising demand (Avnimelech, 2009). Therefore, it calls an innovative and efficient technology that would increase the productivity of the aquaculture production system without endangering the limited natural resources. Among the strategies to improve the aquaculture production, efficiency utilization of feed nutrient is one of the prime strategies. This could be achieved either by improving the feed quality whereby enhancing the nutrient availability or by re-utilizing of waste nutrient in the system by applying some modifications (Bossier and Ekasari, 2017). In this context biofloc technology can be considered as one of the most viable and economically feasible option.

What is Biofloc?

Biofloc is a total mixture of suspended particles and choice of microorganisms related with extracellular polymeric substances. These organisms have the capacity to transform the unseed feed and excreta into protein rich feed in the presence of sunlight. On an average, the biofloc contains protein (38-50%), lipid (3%), fiber (6%) ash (6%) and energy (19kj/g) (Avnimelech, 2015). Generally, each floc of size varying from 50-200 microns are held together in a free network of bodily fluid that is discharged by microscopic organisms and bound by filamentous microorganisms or electrostatic fascination.

Concept of biofloc technology

The basic principle of biofloc aquaculture relies on the concept of carbon nitrogen (C/N) ratio. Biofloc technology offers to enhance the activity of heterotrophic microbiota by maintaining adequate C:N ratio through supplying of additional carbon to the water and finally yielding microbial protein biomass (Avnimelech, 1999). The unconsumed feeding materials and the digested materials released from the aquatic animals have led to the production of nutrient waste in the aquaculture production system. Thus, the treatment of waste water treatment will play a significant role in improving the culture system. Biofloc technology not only aims to improve the water quality by treating the waste materials and but also reutilized the nutrient waste in the system. The proper maintenance of C:N ratio through the addition of right amount of carbohydrates in the system will enable to convert the nitrogenous into microbial protein biomass In other words, the biofloc technology aim to improving the water quality by providing adequate amount of carbohydrate with the help of beneficial microbes inhabited in the system (Figure 1). The desirable normal ranges of various water parameters in biofloc technology for tropical condition are presented in Table 1.

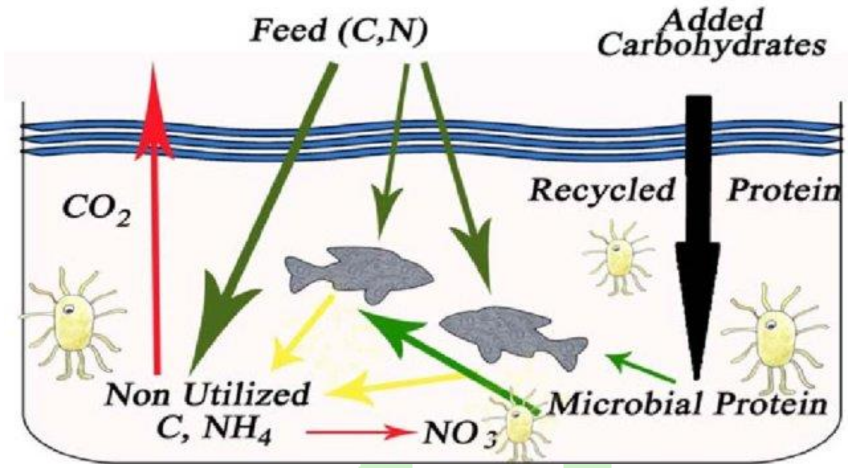

Figure 1: Scheme representation of biofloc technology (BFT) system (Source: Avnimelech, 2009).

Avnimelech (2007) have represented the biofloc production system in equation form as follow:

$$D[BF] / dt = BF_{production} - (BF_{harvesting} + BF_{degradation})$$

Where D[BF] / *dt* is the biofloc concentration change with time, which is determined by level of production, harvesting by fish and biodegradation.

From this equation, it was summed that the production of biofloc is influenced by a) the source and quality of organic substrates to the microbial community; b) fish species and thier feeding traits, fish size, floc size and floc density; c) biodegradation of the floc depends on the microbial community associated with the bioflocs and; d) prevailing environmental and operational conditions such as temperature, water salinity, water exchange rate mixing intensity etc.

Table 1. Main water quality parameters monitored in BFT systems and its ideal and/or normal observed ranges (Adapted from Emerenciano *et al.,* 2017)

Parameter	Ideal and/or normal observed ranges	Observation
Dissolved oxygen	>4.0	For correct fish, shrimp, microbiota respiration, and growth
Temperature	28–30°C (ideal for tropical species)	Besides fish/shrimp, low temperatures (~20° C) could affect microbial development
pH	6.8–8.0	Values less than 7.0 is normal in biofloc technology but could affect the nitrification process
Salinity	Depends on the cultured species	It is possible to generate BFT, e.g., from 0 to 50 ppt
TAN	Less than 1 mg L^{-1} (ideal)	Toxicity values are pH dependent

Nitrite	Less than 1 mg L^{-1} (ideal)	Critical parameter (difficult to control). Special attention should be done, e.g., on protein level of feed, salinity, and alkalinity
Nitrate	0.5–20 mg L^{-1}	In these ranges, generally not toxic to the cultured animals
Orthophosphate	0.5–20 mg L^{-1}	In these ranges, generally not toxic to the cultured animals
Alkalinity	More than 100 mg L^{-1}	Higher values of alkalinity will help the nitrogen assimilation by heterotrophic bacteria and nitrification process by chemoautotrophic bacteria
Settling solids	Ideal: 5–15 mL L^{-1} (shrimp), 5–20 (tilapia fingerlings) and 20–50 mL L^{-1} (juveniles and adult tilapia)	High levels of SS will contribute to the DO consumption by heterotrophic community and gill occlusion
Total suspended solids	Less than 500 mg L^{-1}	Idem to SS

Advantages of Biofloc

- Provides sustainable and ecologically friendly culture system
- Helps in reducing the pollution load thus improving the water quality of the culture system
- Controls the introduction of pathogens thus preventing the disease infection to aquaculture production system
- Recycling and reuse the nutrient waste through microbial activity
- It helps in improving the feed conversion ratio (FCR) and thus reducing feed cost
- It offers higher stocking of fish and thus enable to yield higher production
- It promotes the growth, survival and healthy rearing system
- It creates zero or minimal water exchange
- It also helps in maintaining temperature and heat fluctuations in the system

Diasdvantages of Biofloc

- It required more energy for mixing and aeration process
- Promotes higher water respiration by lowering response time
- Requirement of initial start-up period
- Requirement of additional alkalinity supplement
- Risk for increasing nitrate accumulation in the culture system
- It may produce inconsistent and seasonal performance for sunlight-exposed systems

CONCLUSION

With the aim to increase the aquaculture production, an innovative and sustainable efficient technology that would increase the productivity of the aquaculture production system without endangering the limited natural resources is highly required. In this context, biofloc technology seems to be the most appropriate and viable option. This technology offers to solve the problems of nutrient waste management and overall increase the water quality and productivity of the culture system. Still, lot of research works in this aspects have to be done in the coming years.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

An overview on crop models in horticulture

Article id: 22869

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INTRODUCTION: To draw out a plan of work to grow crops to get maximum possible yields of high quality produce and a reduction of inputs. Farming is a complex agri-business where many activities are taken together like cultivation of cereals, fruits and vegetables, animal rearing and poultry. However, cultivation of various crops, including fruits and vegetables are generally the major components of a farming system. Agronomic practices adopted for a crop depends on many factors that include climatic factors, ecological environment, resource availability, and the level of knowledge about agro-techniques required for the crop. It is thus important to understand the impact of each factor on the growth and yield of the crop. This can be done independently or in association with other factors. Crop models allow us to do this so that we can changes required to improve our overall management of the farm.

Crop model – First let us understand what we mean by crop model. In very simple terms we can define a crop model as (i) a well thought-out plan of activities to grow the desired crop to get maximum possible yields of high quality produce with the given resources. It can be a mental or a written exercise (a “schematic representation of the system”) that a farmer or a farm manager prepares for a crop or for an individual crop. In other words, we can also say that a model is (ii) “an attempt to describe a certain process or system through the use of a simplified representation, preferably a quantitative mathematical expression, that focuses on a relatively a few key variables that control the process or system”. Successful farming depends on our knowledge of the impact of ecological, climatic and economic factors on crop yields. So, a model may be defined as (iii) “an attempt to describe a certain process or a system through the use of a simplified representation, preferably a quantitative mathematical expression that focuses on relatively few key variables that control the process or a system”.

Utility of crop models - Crop models help us to understand the crop production process or system in a more systematic way. The process of modeling is often equated to solving of a puzzle. A puzzle has to be considered as a whole even if we need to fit a one small block. Crop models provide us quantitative information about the amount of inputs like the doses of fertilizers, number of irrigations, amount of insecticides/pesticides, etc. required. These models also help us to consider various input requirements under different climatic conditions. This means models help us to get reasonably clearer picture of otherwise hazy scene. It is also said that models provide us reasonably acceptable answers to questions where we can only have vague answers. So we must be clear that models would not guarantee one hundred per cent accurate answers; even if we take a large number of variables into consideration. This is because crop cultivation is a biological activity and the final output depends on our knowledge of the state of climate that will prevail during the growing season, our knowledge about the appropriate technology required, availability of that technology, about input market conditions, about the biological risk factors associated with the crop, and such other factors. It is clear from this discussion that in finalizing a crop model we have to assume some mean or standard values (based on the past record, experience, expert judgment, etc.) of the variables which we may not be taking explicitly in our model. Since, there can be a large number of factors that may affect the crop, it becomes easier to understand their effect if these variables are grouped on some basis. Thus we may have a group of ecological variables, economic and social variables, technical and climatic factors that may need to be considered in our crop models.

Types of crop models - Based on different groups of variables that affect crops production, we can categories crop model or models as; (i) *ecological models,* (ii) *climatic models, and* (iii) *socio-economic models.*

- The climate based models are formulated to predict the correlation of climatic variables (like temperature, rainfall or snowfall, humidity, day length, chilling hours, etc.) with a given biological phenomenon like survival rate of species, growth of vegetative parts, fruit-set, crop maturity or the crop yields, etc. These models are also used by the ecologists to identify the variables which affect the crop yields through their impact on modifying the local climate.
- Understanding the interactions of farming systems with the surrounding environment is thus important for success in agribusiness and modeling helps us in doing the same.
- The crop models with as many variables as possible are thus better in making predictions than the models with a few variables. However, modeling with a very large number of variables may not always be possible because of the problems of lack of relevant data, mathematical programming problems, etc. Most of the times, therefore, we have models with the variables in which we have the immediate interest.

Production Function – an algebraic representation of a model

Most common crop models are the economic models analyzing the effect of some inputs on crop yields. In these models, influence of an independent variable is estimated on the crop yield or on the growth of the crop. � We know that a production process is a set of sequence of rules for using different inputs that needs to be followed for using different inputs. The ultimate outcome of a production process is the final output of that process, i.e. the crop yield or the desired vegetative growth. In a simple modeling scenario, a production process can be considered as a *production function* (a mathematical or the symbolic expression of a production process). A production function is the most common crop model.

In general, a production function can be algebraically represented as;

$Y = f(X)$, Where; Y is the *dependent variable (say output*) which depends on the amount of input (X) used. Since we can change the level of input being used, X, is also called an *independent variable*. We assume that the level of technology being used remains the same during the production process. For a multiple inputs case, a production function will take the following form; indicating that the final output depends on, or is a function of „*n*‟ inputs or „*n*‟ independent variables.

Y = *f* (X1, X2, X3, . . . , Xn-1, Xn).

However, it is common to analyze the effect of a single factor of production on an output; while the other variables are held constant at their mean use level or at predetermined levels. We can thus rewrite the above equation for a production function as follows;

Y = *f* (X1/ X2, X3, . . ., Xn-1, Xn).

The equation shows that although the output, Y, is a function of „n‟ independent variables, currently, however, the effect of a single variable, X1, is being analyzed and other variables have been kept constant (at their mean level of input use, or say at their current level of use). The functions can have linear, quadratic or other forms; and a suitable form is to be selected for detailed analysis. We can graphically represent the response of a dose of an independent variable, or a package of inputs, on the dependent variable (output) by plotting the output obtained by the use of each dose of the input in a production trial. Such a representation of the production data is termed as the response curve or the total product curve (Fig.1). The shape of the response curve for a product depends upon the nature of the product and the production process being used. The response of different inputs, under given production conditions may be different over the range of a response curve. Response to application of input(s) may be increasing, decreasing, or even constant. Technically, we refer to these responses as the increasing, decreasing or constant *returns* to variable inputs, respectively. To analyze the 244ehavior of the response curve, it is always helpful to look at the average and marginal components of this curve.

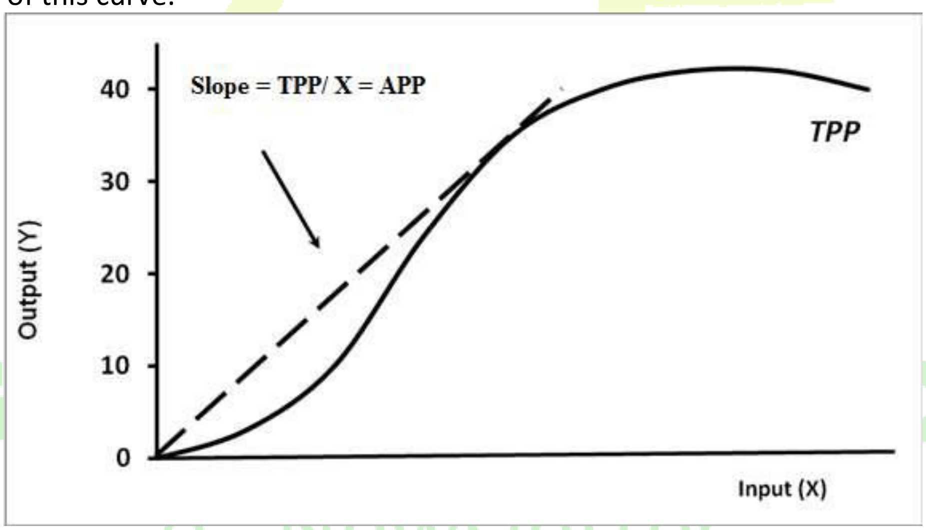

Fig .1. Response curve or the total product curve

Average response, or average product (AP) as it is commonly known, is defined as the output produced per unit of input used. Marginal product (MP) or marginal response, on the other hand, is defined as the change in total output resulting from a unit increase in input.

Algebraically;
AP = Y/X, and MP = ΔY/ΔX. Where, Δ denotes the change; so when we estimate the change in Y, as a result of a unit change in X, we have estimated the marginal product. If we plot the average and marginal outputs, we can then add two more curves to the above figure showing the total response curve. It now becomes more intuitive to visualize as to what happens to the shape of the total product curve as the input use is increased. The two additional curves allow us the clearer picture of the average and marginal response to the input use.

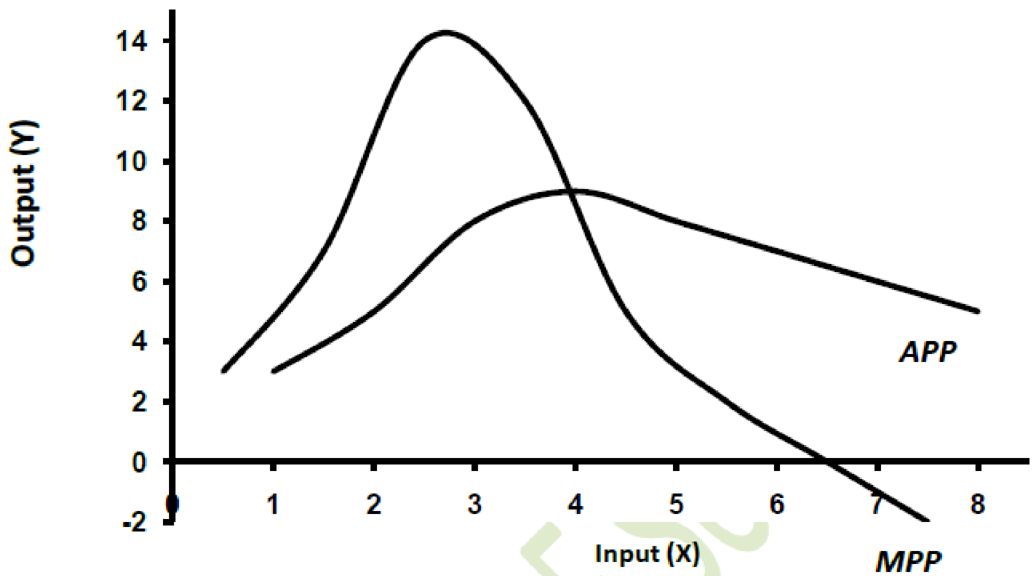

Fig. 2: Average and marginal product curves

We note that geometrically, MP is the slope of the total product curve. The behaviour of the marginal product curve reflects the output behaviour (i.e., the relationship between inputs and output) in response to the increase in a unit of input. When MP is increasing we say we have increasing marginal returns; that is when with the successive dose of input the addition to the total product is higher than the addition made by the previous dose of input. Similarly, when MP is decreasing, or constant, we have respectively the decreasing or constant marginal returns function.
Summarizing, if;

ΔY1/ΔX1 < ΔY2/ΔX2 <- - - <ΔYn/ΔXn we have increasing marginal returns

ΔY1/ΔX1 > ΔY2/ΔX2 >- - - > ΔYn/ΔXn we have decreasing marginal returns

ΔY1/ΔX1 = ΔY2/ΔX2 = - - - = ΔYn/ΔXn we have constant marginal returns.

It is possible that for an activity we might notice increasing, constant and decreasing returns over the range of total product or response curve. This happens as a result of varying capacity utilization of the fixed resource due to increased use of variable inputs. As for example, in case crops the per unit response to input use is higher in the initial stages when the productive capacity of a fixed resource, say for example land, is not fully utilized. So when more input is used the output obtained per unit of additional input used is increasing. Later, the response may be constant over a restricted range and then it declines when the land resource gets over utilized. Most common examples of such responses are the fertilizer applications on a given piece of land or the number of irrigations in an irrigation trial. In both these cases, the yield response to initial input doses are higher and the response declines as we continue using additional doses of inputs. Finally, there may be losses due to toxicity or lodging etc., if the input use is continued beyond the absorptive capacity of land and the crop. Thus, it becomes important to decide as to what level of production (and thus the level of input use) is desirable or profitable and where one should stop using the input. It is important to consider economic aspects (profitability) because the inputs are scarce and have to be paid for. If the inputs are not scarce or are not paid for, then in general, one might target the biologically maximum yield. This mostly is the case in research trials where we need to find out the maximum yield or total production of the crop.

Applications in horticulture: Modeling has become relatively easy now with the use of computers. Computers help in reducing the complications of handling voluminous data. Therefore, apart from annual crops, modeling for perennial fruit trees is also commonly done. In the field of horticulture, the crop models are needed for modeling yield forecast, policy analysis and management options. It is very important to predict yields so as to prepare ourselves for marketing of the produce in a hassle-free manner. For example, it is important to know the timings of the arrivals of different produce in the market. If, through modeling, we can get an idea when the marketing season would be a lean season, and how we can change our harvesting to target this period, we can increase our profits. Similarly, we can target the production of flowers and pot-plants to suit the important fairs and festivals in a region. Well framed crop models can give us an idea of how we can improve some characteristics of the produce (e.g. in terms of length of stems, size of flowers etc.). The same is true for cultivation of vegetables. In perennial crops/fruit trees we need to model "the architecture of fruit trees and the relations between pruning and flower and fruit development" for maintaining the vigour of the trees. Such modeling is generally called biological modeling. When we combine the biological and economic considerations, we say we are doing a bio-economic modeling. The economic content of the model relate to the costs and returns from the production process while the biological content refers to the physiological production processes from planting to maturity of the crop. The annual fruit production is determined by the biophysical model which may use factors like tree density, pruning/training regimes.

Fruit tree models: The perennial nature of fruit tree implies that tree growth and the yields are also dependent on previous years‟ growth and health of the tree. In deciduous fruit trees, for example, the number of flowers, and thus crop potential is determined by the condition of the plant in previous season. In fruit trees there is "a perennial woody skeleton which not only grows and develops during the annual cycle, but also accumulates and exports carbohydrates and other reserve materials. This complicates the estimation of the net increase in biomass of a fruit tree during the annual cycle". Nevertheless, we model the response by taking various assumptions or by keeping some of the factors at a known level in the model. Goldschmidt & Lakso have suggested an option for an overall, quantitative description of fruit tree‟s annual productivity through equations of carbon (C) supply and consumption. The equation is as under;

Pn + Sto = Sr + Rr +Dr + Fn.w.r + Pr + Sto where;

Pn = photosynthetic production

Sto = non-structural carbon reserves

Sr = current year‟s shoot mass (including leaves and stem) multiplied by a respiratory quotient

Rr = current year‟s root mass, multiplied by a respiratory quotient

Dr = current year‟s drop of flowers and fruit-lets, multiplied by a respiratory quotient

Fn.w.r = fruit number, multiplied by fruit weight (w), multiplied by a respiratory quotient

Pr = perennial organ mass, multiplied by a respiratory quotient.

This expression indicates the major parameters that need to be determined experimentally or compiled from existing data in order to estimate annual productivity.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Induced Systemic Resistance and its importance in eco-friendly disease management in vegetable crops

Article id: 22870

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Vegetables are the indispensible portion of our daily diet with low calorie and high nutrients. But the production and productivity is greatly hampered by the occurrence of several devastating diseases. Management of such diseases through chemical methods uplifts the cost of cultivation as well as results into health and environmental hazards. In this context, induction of systemic resistance of plants by use of naturally occurring bacterial species is perhaps the most economically sound method of disease management. The elevated resistance upon infection by a Plant Growth Promoting Rhizobacteria (PGPR) is called Induced Systemic Resistance (ISR). This is a generalized resistance naturally present in plants but it is activated by the biotic factors. As it is systemic in nature, inducing resistance in a particular plant-part will also protect the other parts from pathogen invasion. Sometimes, upon induction, some gaseous-hormonal signal is produced by the host plants, which will reach to other plant parts and also to the nearby plants to trigger the defensive response of the plants.

Characteristics of ISR (Van Loon and Bakker, 2005)-

- The defensive capacity of the plant is enhanced through microbial stimulation or similar stresses.
- The enhanced defensive capacity is expressed systemically throughout the life cycle of the host plant.
- It is active against fungi, bacteria, viruses and sometimes against insect-pests and nematodes.
- The interaction is very specific to a host-microbe combination(s) but results into a broad spectrum resistance.
- Priming of the host plants at molecular level helps the plant to become capable of withstanding the invading pathogens whereas non primed plants get the disease.

Induction of Systemic Resistance

ISR can be induced by exposing the compatible host plant to a particular and strain of PGPR. Among the large groups of bacteria, species belonging to three genera *viz., Bacillus*, *Pseudomonas* and *Rhizobium* are mostly been employed. Out of these three bacterial genera, *Pseudomonas* sp. is more common. Among the different species of *Bacillus*, *B. amyloliquifaciens*, *B. subtilis, B. pasteurii, B. cereus, B. pumilus, B. mycoides* and *B. sphaericus* are more common. Plant Growth Promoting Fungi (PGPF) *viz.,* Vasicular Arbascular Mycorrhizae (VAM) is also used.

Methods of application of PGPRs

- Soil drenching of PGPR strains in growing crops as well as in the nursery.
- PGPR formulations can be mixed with the transplanting mixture or potting media.
- Dipping of the roots in PGPR before transplanting.
- Seed treatment before sowing

Modes of action of PGPRs

Plant Growth Promoting Rhizobacteria (PGPR) confers different mechanisms for suppressing plant pathogens, they include competition for nutrients and space (Elad and Chet, 1987), antibiosis by producing antibiotics *viz.,* pyrrolnitrin, pyocyanine, 2,4-diacetyl phloroglucinol (Pierson and Thomashow, 1992) and production of siderophores (fuorescent yellow green pigment), *viz.,* pseudobactin, which limits the availability of iron to the pathogens and ultimately reduces the growth and reproduction of the pathogenic organisms (Lemanceau *et al.,* 1992). Other important mechanisms include production of lytic enzymes such as chitinases and β-1,3-glucanases which degrade chitin and glucan present in the cell wall of fungi (Velazhahan *et al.,* 1999) and bacteria, respectively; production of Hydrogen Cyanide (HCN) (Defago *et al.,* 1990) and degradation of toxin produced by pathogen (Duffy and Defago, 1997). Other than these direct mechanisms, they induce systemic resistance in the plants.

Advantages of Induced Systemic Resistance

- The resistance is stable and durable as several pathways are involved.
- It is economical as the inducing bacteria are naturally available, only identification and mass multiplication is required.
- It is environmentally safe and is particularly beneficial in disease management in organic farming.
- Resistance conferred by ISR is much more durable than Systemic Acquired Resistance.
- There is no chances of resistance development of the pathogenic microbes.
- Provides broad spectrum resistance against fungi, bacteria and viruses.
- Two or more beneficial PGPRs act synergistically and ensure a better resistance [application of a mixture of two chitinolytic bacterial *viz*., *Paenibacillus* sp. was more effective than their individual application for the management of *Fusarium* wilt of cucumber (Singh *et al.,* 1999)].
- In vegetatively propagated vegetable crops like cassava, potato, taro, yam *etc.* the use of endophytic PGPR will eliminate the requirement of repeated PGPR to induce ISR, as these bacteria will remain inside the plant parts, which will be used for propagation.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Molecular properties of Induced Systemic Resistance

- ISR is independent of Salicylic Acid pathway. However, some reports are there that the salicylic acid is also involved in ISR.
- ISR is independent of Pathogenesis Related (PR) gene activation.
- ISR requires Jasmonic Acid and Ethylene responsive gene activation as well as the sensitivity of the plant towards Jasmonic Acid and ethylene.
- Regulatory protein NPR1 (Non-expressor of PR proteins) is required in ISR.
- Systemin is also involved in the induction process.

Mechanisms of induced systemic resistance

- Developmental resistance- escapes the disease which is linked to growth promotion.
- Physiological resistance- tolerance is characterized by reduced symptom expression and no significant reduction in yield.
- Environmental resistance which is associated with microbial antagonism in the rhizosphere.
- True resistance mediated through priming i.e. induction of cell wall reinforcement, induction of phytoalexins and production of lytic enzymes *viz*., chitinase and β-1,3 glucanase.

Pathway of Action of Induced Systemic Resistance

A. Ethylene Pathway: Ethylene is the only gaseous hormone which is synthesized from methionine amino acid. It is a major signaling molecule for Induced Systemic Resistance.

B. Jasmonic Acid Pathway: It is a plant signaling molecule derived from alpha-linolenic acid in plant system and also produced by certain fungi. The first compound in this group i.e. Methyl jasmonate was first isolated from the essential oil of *Jasminum grandiflorum* (Demole *et al.* 1962), whereas, from fungi, it was first isolated from culture filtrate of fungi *Lasiodiplodia theobromae* (Aldridge *et al*. 1971).

Examples of Induced systemic resistance against diseases in vegetable crops

Crop	Bacteria	Strain	Resistance against	Reference
French bean	*P. aeruginosa*	7 NSK2	Broad spectrum	[4]
	P. putida	WCS 358	Broad spectrum	[15]
	P. fluorescens	97	*Pseudomonas syringae pv. phaseolicola*	[2]
Tomato	*P. putida*	WCS 358	Broad spectrum	[15]
	P .fl uorescens	89B61	*Phytophthora infestans*	[24]
	P. fluorescens	WCS 417	*Alternaria sp.* and *Fusarium sp.*	[9]
	P. fluorescens	Pf1	*Rhizoctonia solani*	[17]
	P. fluorescens	Pf1	*Pythium aphanidermatum*	[19]
	P. fluorescens	63-28	*F. oxysporum* f. sp. *radicis-lycopersici*	[16]
Radish	*P. fluorescens*	WCS 374	*F. oxysporum* f. sp. *raphani*	[11]

	P. fluorescens	WCS 417	*F. oxysporum* f. sp. *raphani*	[9]
Cucumber	*Pseudomonas putida*	89B-27	*F. oxysporum* f.sp. *cucumerinum*	[13]
	Serratia marcescens	90-166	*F. oxysporum* f.sp. *cucumerinum*	[14]
	P. putida	89B-27	Bacterial wilt	[10]
	Serratia marcescens	90-166	Bacterial wilt	
	Serratia marcescens	90-166	*Pseudomonas syringae* pv. *lachrymans*	[14]
Cucumber and tomato	*P. fluorescens* (89B-27) & *Serratia marcescens* (90-166)		Cucumber Mosaic Virus	[20]
Pea	*P. fluorescens*	63-28	*Pythium ultimum*	[3]

Disadvantages of Induced Systemic Resistance

- Physiological cost of induced resistance- much assimilates of the plants will be used up for induction of resistance even if the pathogens are not at all landing on the plant (Van-Hulten *et al.,* 2006).
- Sometimes the beneficial microbes also assist in the entry of the pathogenic microbes (Venturi and de Silva, 2012).
- Delay in plant maturity in pepper upon induction of ISR (Romero *et al.,* 2001)
- ISR can sometimes make the target plants more vulnerable to a pathogen which was otherwise a minor concern.

CONCLUSION

In several experimental studies, PGPRs promoted plant growth and also conferred resistance to several pathogens in different vegetable crops by induction of systemic resistance. Therefore, for eco-friendly and cost effective management of diseases of vegetable crops, Induced Systemic Resistance will play a vital role in near future.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Study the Complexity of Stress Mechanism Using "Omics" Approach

Article id: 22871

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INTRODUCTION:

Stress is an unfavourable condition that affects the usual growth and development of crops and ultimately reduces the yield. Crop plant stress is categorised into biotic stress (Virus, Bacteria, Fungi) and abiotic (*e.g.*, High and low temperature, Drought, Light). Generally stress can, causes damage by disturbing the physiological and biological processes of crops that leads to cellular tissues damage or cell death. Although the numbers of signalling pathways were switch on or off during stress condition are difficult to predict, it is necessary to put together multidimensional information in the variety of models and networks.

"Omics" approach is the way to understand and identify with the mechanism of response and tolerance under stress at molecular level with the help of genomics, proteomics, transcriptomics or metabolomics.

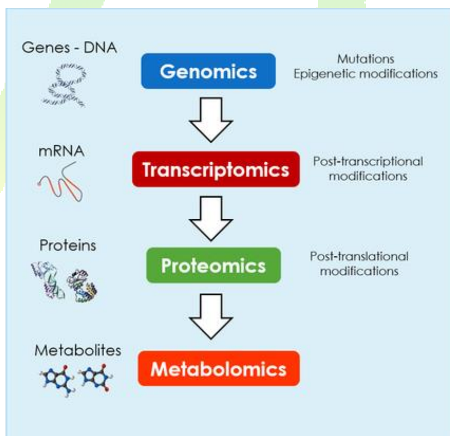

Fig. Different Omics approaches

Omics: Approaches for Understanding Stress Responses

Developing stress resilient crops through the conventional and non-conventional method of breeding is the need of the hour. This is necessary to understand the complexity of the stress mechanism. Adaptation of plant under stress condition can be adjusted by regulating crops physiological, cellular and molecular activities. "Omics" approaches might provide as the most direct and potential strategies for improving stress tolerance in crops

Candidate Gene Identification Using Functional Genomics

Functional genomics offers deep understanding of mechanisms of crop tolerance to biotic /abiotic stresses, through information regarding the molecular pathways employed by the crop plants, in addition to the function of the concerned genes involved. As soon as plant cells recognize external stimuli, discrete cascades of molecular responses are differentially stimulated and network of signalling become active. These different signalling pathways were tend to meet to form hubs viz. Phytohormones and transcription factors (TFs). These different hubs join the molecular network through physiological responses under a variety of stresses.

Transcriptomics

At the DNA (genome) level, function of gene is analysed using sequencing and bioinformatics studies while some methods have been developed to analyze the (RNA) (transcriptome) of an crop plants. Various strategies are available for analysis of transcriptome consist of,

1. Hybridization methods (Oligonucleotide microarrays, DNA microarrays, northern blots)
2. cDNA fingerprinting (cDNAAFL, differential display)
3. RT-PCR (qualitative and quantitative)
4. cDNA sequencing (SAGE, normalized cDNA libraries, massively parallel signature sequencing-MPSS, full-length cDNAs, subtracted cDNAs) Oligonucleotide and cDNA microarrays have been commonly used in plants, including Maize, *Arabidopsis*, strawberry, lima bean, petunia, and rice to compare and study global gene expression patterns. Oligonucleotide microarray investigation has also been used to study the global gene expression profile of rice under a variety of biological, environmental, and chemical stress treatments.

Proteomics

Study of the proteome consist knowledge of total protein repertoire in addition to studies on other characteristics, such as level of expression, post-translational modifications and its interactions, for the understanding of the cellular processes at the protein level. Structural proteomics consist of the studies of protein structures various techniques such as NMR spectroscopy and X-ray crystallography. Functions of novel genes were discovered and identified after protein structure comparisons. It comprises the analysis and comparisons of protein expression at a larger scale. It helps to detect key proteins in a specific sample, and those proteins that are differentially expressed in other samples.

Metabolomics

Metabolomics offers a general idea of the global biochemical events and metabolic status linked with a biological or cellular system. It can comprehensively and accurately represent both the physiological state and steady-state of a organism or cell and of their active responses to biotic and abiotic environmental fluctuation. A various of metabolomic analysis have been performed to study plant responses to dought, temperature, salinity, phosphorus, sulphur, heavy metal and oxidative stress in addition to a overlapping of different stresses. The association among stress tolerance and metabolite content has been studied in several wild species of introgression lines and tomato.

CONCLUSION: Whole genome sequencing of several plant species has been finished, and a lot of are in progress. On the basis of these genome sequences, whole catalogue of genes have been predict in these plant species, but assigning a gene function to these sequences will continue most complicated job due to sequence of DNA is not always translated into mRNA and proteins levels may or may not compare with the amount of metabolite or protein levels. For that reason, the key goal of plant molecular biologists is to decode the genes function such as those responsible for biotic/abiotic stress tolerance. While for the comprehensive understanding of stress tolerance network and its mechanisms, need integration of systematic analyses of the genomics, transcriptomics, proteomics, and metabolomics in parallel is necessary.

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Organic seed production

Article id: 22872
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INTRODUCTION

The term “organic seed” means seed produced under an organic system, ideally one that is certified. Growing crops for seed requires a longer season since the crop must stay in the field twice as long as a conventional crop harvested for grain and also for increased monitoring to ensure high seed quality and purity. Standard production of seeds requires chemical herbicides, insecticides, fungicides, and fertilizers. An increase in the amount of chemical products used on seed crops may occur due to the length of time the crops remain in the field. As a result, plant diseases and insects get more time to attack the crop during seed maturation. With these factors playing a role in conventional seed production, the challenges for organic seed production are increased. The most compelling reason for using organic seed when growing organic crops is that seed produced organically causes less chemical impact on the environment.

A. Land selection

- Land should be organically managed.
- Avoid the low lying area to restrict the run off water contamination from conventional farming system.
- To avoid contamination from wind, the organic farm shall be separated from conventional farm by live fence or manmade organically managed crop can be maintained as buffer zone.
- A buffer zone of at least 3 meters shall be maintained between conventional and organic management land.
- The equipment or implements used for organic management shall be cleaned before use.
- Crops should be rotated to reduce pest problems and any potential for seed contamination by open pollination with similar species types.
- The seed production field should not have known weed problems that are too difficult to control through organic means

B. Land preparation

- Soil should be tilled to ensure a fine seed bed, which is critical for germination, particularly with small-seeded crops.
- The soil should have good water-holding capacity to allow for uniform germination and continued vegetative growth.
- The beds should be raised and shaped depending on rainfall.

C. Soil fertilization

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

- It is important that the fertility of the soil is improved when producing organically since chemical fertilizers cannot be used.
- To ensure good soil fertility and fewer soil borne diseases, crop rotation, use of a cover crop, green manure crops, mulch, animal compost, and plant material compost can be used.

D. Choice of crop and varieties

- Any crop of variety/hybrid except genetically modified organisms/crop which suits to the location shall be used or grown.
- Pest and disease resistant varieties are mostly preferred

E. Seeds and planting material

- Seeds/planting material shall be used from organically certified source.
- In case of unavailability of organic seed, untreated seeds from conventional farm shall be used for first year and for subsequent years organic seeds shall be used.
- In case of growing other varieties which are not grown in the first year, chemically untreated conventional material shall be used.
- Genetically engineered seeds, pollen, transgenic plants or plant materials shall not be allowed

F. Plants used for seed treatment

✓ **Plant leaf extract and leaf powder**

The plant leaf extract was prepared by grinding the fresh leaf with water. The leaf powder was prepared from dried leaves.

✓ **Rhizome powders**

The dried rhizomes are powdered and used for seed treatment. The chemical substance or active principle present in this powder induced the protection against the insects and pathogens.

✓ **Seed/ plant oil**:

The oil extracted from seed and plant parts are used for seed treatment

Name of the plants and parts

Common name	Scientific name	Parts used
Arappu	*Albizia amara*	Leaf
Pungum	*Pongamia pinnata*	Leaf/ Seed
Neem	*Azadirachta indica*	Leaf/ Seed
Karuvel	*Acacia nilotica*	Leaf
Prosopis	*Prosopis juliflora*	Leaf
May flower	*Delonix regia*	Leaf
Hariyali grass	*Cyanodon dactylon*	Leaf
Hibicus	*Hibiscus rosasinensis*	Leaf
Mint	*Mentha spicata*	Leaf
Milk weed	*Calotropis procea*	Leaf
Mahendi	*Lowsonia inermis*	Leaf
Notchi	*Vitex negundo*	Leaf

Sambangi	*Telosma minor*	Leaf
Drumstick	*Moringa oleifera*	Leaf
Tamarind	*Tamarindus indica*	Leaf
Bougainvillea	*Bougainvillea* spp.	Leaf
Basella	*Basella ruba*	Leaf
Beetroot	*Beta vulgaris*	Leaf
Marigold	*Tagetus erectus*	Leaf
Opuntia	*Opuntia* spp.	Leaf
Garlic	*Allium sativum*	Rhizome
Turmeric	*Curcumba longa*	Rhizome
Vasambu	*Acorus calamus*	Rhizome
Chilli	*Capsicum annum*	Seed
Sikkai	*Acacia concinna*	Seed
Soapnut	*Sapindus trifoliatus*	Seed
Jamun	*Syzygium cuminii*	Seed

G. Rouging

- Rouging at periodical intervals to remove the off types from both in male and female lines during hybrid seed production.

H. Weed, pest and disease management

- Management of weeds and pests is critical to ensure that organically produced seeds have high yield and quality.
- Weed can be managed through mulching with plant residues and other fully biodegradable materials, livestock grazing and hand weeding coupled with mechanical cultivation.
- The seed crop is in the field for a long period of time, there are many opportunities for multiple pathogens to interact with a single crop.

I. Harvesting, threshing and drying

- Harvesting the male parents line should be done first.
- Method of harvesting depends on the type of seed being produced.
- When harvesting dry-seeded crops, seed shattering must be prevented because seed harvest generally occurs after the crop reaches physiological maturity.
- To reduce shattering, the stalks of the plant need to be cut while stillgreen and field dried, allowing for uniform seed maturation.

J. Cleaning and Storage

- Once seeds are harvested, threshed and extracted.
- They should be evaluated to determine the physical purity.
- All seeds should be single units and all should be stored according to their individual temperature/humidity requirements.
- Generally moisture content should be below 12% for storage.

K. Organic Seed Certification

In simplified terms, the National Organic Program Standards require for crop farms:

- 3 years (36 months prior to harvest) with no application of prohibited materials (no synthetic fertilizers, pesticides, or GMOs) prior to certification
- Proactive steps to prevent contamination from adjoining land uses
- Implementation of an organic system plan, with proactive fertility management systems;
  conservation measures; and environmentally sound manure, weed, disease, and pest management practices.
- Use of natural inputs and/or approved synthetic substances on the National List, provided that proactive management practices are implemented prior to use of approved inputs
- No use of prohibited substances , no use of genetically engineered organisms (GMOs), defined in the rule as “excluded methods” and no use of sewage sludge or irradiation
- Use of organic seeds, when commercially available (must not use seeds treated with prohibited synthetic materials, such as fungicides)
- Use of organic seedlings for annual crops
- Restrictions on the use of raw manure and compost
- Must maintain or improve the physical, chemical, and biological condition of the soil, minimize soil erosion, and implement soil building crop rotations
- Fertility management must not contaminate crops, soil or water with plant nutrients, pathogens, heavy metals or prohibited substances
- Maintenance of buffer zones depending on risk of contamination
- No field burning to dispose of crop residues and no residues of prohibited substances exceeding 5% of the EPA tolerance.

CONCLUSION

Organic agriculture with organic seed includes growing of crops by a set of guidelines that prohibit the use of synthetic products/ chemicals such as fertilizer, pesticides and herbicides. Therefore, soil fertility and pest management is achieved through cropping patterns (rotations, inter/mix-crops, pest and disease-resistant genotypes), manure (green manure, organic manures and compost), biofertilizers, cultural practices (weeding, planting, conventional tillage) and biopesticides, including plant derived products. At present this system seems to be an ideal and valid solution to produce seeds aside with the agriculture production. The overuse of plant growth regulator, pesticides and fertilizer for faster growth of agriculture produce is detrimental to human health and environment as a whole. Further, consumers are becoming conscious and critical about the quality of food and by-product that affect their health though the toxicity depends to some extent of the type of food consumed

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Measurement of Phytotoxicity of pesticides

Article id: 22873

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INTRODUCTION

Phytotoxic means harmful or lethal to plants. Herbicides are especially hazardous to plants because they are designed to kill or suppress plants. Some insecticides and fungicides can also harm plants.

Phytotoxic properties of insecticides are usually associated with specific formulations (wettable powder, emulsifiable concentrate, granule, etc.) or particular plants rather than groups of pesticides or plants. Phytotoxic effects can range from burning of leaves to death of the plant. Sometimes the damage appears as distorted leaves, fruit, flowers or stems. Damage symptoms may vary with the pesticide and the type of plant that has been affected.

The measurement of phytotoxicity will depend on the type of symptoms produced by the plant. And it is similar to that of disease incidence and severity of the foliar diseases. Phytotoxicity to be assessed on the visual rating from 1-10 scale, based on the percentage of symptoms occur the rating/ score will be given, and the per cent leaf injury was calculated by using the formula below.

Rating	Phytotoxicity (%)
1	0-10
2	11-20
3	21 -30
4	31-40
5	41-50
6	51-60
7	61-70
8	71-80
9	81-90
10	91-100

Scale 10 will be given when insecticides will be used as soil drenching; this leads to the complete plant will die, in such cases, the 100 per cent phytotoxicity will occur.

Per cent leaf injury:

Per cent leaf injury was calculated by using the formula

$$\text{Per cent leaf injury} = \frac{\text{Total grade points} \times 100}{\text{Max. grade x no of leaves observed}}$$

The percentage of inhibitory effect on germination to control

The percentage inhibitory effect on germination to control was calculated by using the following formula, (Surendra and Pota, 1978).

$$I = 100 - (E_2 \text{ X } 100/E_1)$$

- Where I is the % inhibition,
- E_1 is the Response in Control,
- E_2 is the Response in treatment

The percentage of phytotoxic effect on germination to control.

Calculated by Chou and Muller(17972) as follows,

$$PI = \frac{[\text{ radical length in control- radical length in treatment}] \times 100}{\text{radical length in control}}$$

Where PI is the percentage phytotoxicity

CONCLUSION:

Most of the pesticides used in agriculture for the protection from insect pests and diseases produce the different types of the phytotoxicity symptoms. Such as yellowing, chlorosis, blotches, burning and death of the plants, Hence the measurement of phytotoxicity is essential in agriculture.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Mechanical harvesting of sugarcane

Article id: 22874

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INTRODUCTION

Sugarcane is a tropical plant and grown as cash crop in the world. Sugarcane is the most important agro industrial crop next to cotton. The sugar industry is the second largest agro-based industry next to textiles, in the country. India is the second largest sugarcane producer in the world after Brazil, with an average productivity of 70–80 t/ha. Uttar Pradesh, Maharashtra, Karnataka, Gujarat, Andhra Pradesh and Tamil Nadu are the major sugarcane growing states contribute about 81% of the total production in India. Sugarcane remains in the field for almost a year and right from land preparation to harvesting of crop there is heavy demand of labour and machinery throughout its crop cycle.

Sugarcane crop matures within 10-12 months in north India and 12-16 months in south India depending upon the season of the crop. The crop should be harvested when sucrose contents value reaches to minimum 16.5% with 85% juice purity. Thus impurities of sucrose in total dissolved solids are most important factor which governs the maturity of crop. Usually this stage arrives during December-January when atmospheric temperature is about or below 20˚C. Under high temperature conditions, the sucrose gets converted into glucose resulting in poor quality of produce. The yellowing of leaves, emergence of arrows, cane become brittle & brakes easily, cane produce metallic sound and swelling out of buds from nodes are the other indicators of crop maturity.

Harvesting methods of sugarcane

1. Green cane harvesting: Green cane harvesting is done directly without any other treatment of sugarcane before harvest.

2. Burnt cane harvesting: Burnt cane harvesting was done after burning to clear the sugar cane leaves. The pre-harvest burning of sugarcane leaves is a common practice that enables manual pickers to collect the crop quickly, suffering less personal injury. The burning process, however, has negative impacts on the environment, on human health and on the potential energy value of the plant.

Advantages and Disadvantages of Pre-harvest Sugarcane Burning

Disadvantages		Advantages
Economic Drawbacks	***Environmental Impacts***	***Positive Aspects***
Damage to the sugarcane tissue, reducing yields	*Soil degradation and erosion*	*Worker safety*
Reduction in soil fertility	*Emissions of PM, CO CH4, CO2, SOx, NOx*	*Increased productivity of manual workers*
Purification difficulties make	*Biodiversity loss*	*Job creation*

production costly		
When burned, sugarcane rots more quickly, so it must be used faster	*Health problems, especially in the respiratory system*	*Inexpensive*
Necessity of using large amounts of water	*Degradation of riparian forests*	*Reduction of transportation cost*

The green or burnt cane harvested by following methods

- Manual sugarcane harvesting
- Mechanical sugarcane harvesting

Manual sugarcane harvesting

The typical manual sugarcane harvesting system normally consists of manually felling, topping, de-trashing, bundling and loading the canes into the transportation vehicles. Proper manual cutting results in minimum loss of cane and the highest quality of the product. The productivity of manual cutters can be improved by giving them proper training, the use of correct cane knife, balanced diet, etc. In manually cutting is risk for labour as wild animal attacks, snake bite and cutting knife may injure them.

Sugarcane harvesting is a highly labour intensive operation. Labour requirement for sugarcane harvesting ranges between 800–1000 man-hours per ha in tropical regions of India whereas, in the sub-tropics, it ranges between 1200–1500 man hours, which is higher than all other cultural operations.

Mechanical sugarcane harvesting

Mechanisation eliminates the need for burning, speeding up the collection process, eliminating harmful emissions from smoke, reducing crop wastage and thus increasing productivity in terms of energy generation. In addition, mechanical harvesting enables timeliness of operations, reduction of drudgery, better quality work at reduced cost, clearing the field for next crop and increasing overall productivity.

Self-propelled whole stalk harvester

More advanced machines are now available, which cut the cane stalk at the base and detop. The cut canes are placed in a single windrow from 4-6 rows. Subsequently, depending upon the availability of the labour, mechanical loaders/manual loaders can be employed for loading purposes. 8-10% of the trash remains in the harvested cane. At a later stage, use of separate detrashers can be explored for minimizing the level of trash in the cane to be supplied to the mills. The self-propelled whole-stalk sugarcane harvester as a machine for full mechanization of sugarcane harvesting should perform the following functions in sequence.

1. Positioning and handle the cane in respect to functional mechanisms
2. Cut the base of cane stalk.
3. Cut the green top of the cane stalk.
4. Clean cane stalks from dry leaves (de-trashing).

5. Place cane stalk in a suitable manner for further operations.
6. Or convey cane harvested from several furrows and place them together to form a windrow.

Advantages of whole stalk harvester

- Generally, whole stalk harvesting machinery is cheaper to purchase.
- Whole cane sticks deteriorate more slowly than chopped cane and can be stockpiled for considerably longer at trans-loading sites or in mill yards.
- Where field and crop conditions are suitable whole stalk harvesting systems will result in less cane loss and better quality cane compared with chopper harvesting. However, in badly lodged cane the situation could be reversed.
- Because the cutting and loading operations are conducted separately, there is more flexibility when breakdowns occur.
- In most instances whole stalk cutters are fairly simple machines that are easy to operate and require relatively unsophisticated maintenance staff and facilities.

Disadvantages of whole stalk harvesters

- Separate infield loading equipment is required.
- Mechanical loading of whole stalk could increase soil content in the cane sample.
- Most other whole stalk machines cannot operate on slopes greater than 15-20%.
- Transport load densities are lower for whole stalk than for chopped cane.

Chopper harvester (sugarcane combine):

With the increasing labour problem, pace of mechanised harvesting may be accelerated and imported models of chopper harvesters may be tried and introduced with the modifications suiting to local needs. There is no doubt that handling of even a heavy tonnage recumbent crop can easily be handled and output of 25-30 tonnes/field/hour can be achieved but trash percentage in the billets (7-8 %), small size of the fields, high initial cost of the machine, wider row spacing required (1.5 m) and sophisticated systems are the major constraints in successful adoption of these imported machines under Indian conditions. Chopper harvester is the most capable single machine that performs all the operations needed for sugarcane harvesting in one pass. In the chopper harvester should be capable to perform the following sequence of functions:

1. Gather and feed the cane toward the functional mechanisms
2. Cut the base of cane stalk.
3. Cut the green top of the cane stalk.
4. Feed cane stalks inside the machine.
5. Chop cane stalks into billets.
6. Blow out green tops and dry leaves.
7. Elevate chopped cane up to be loaded on a vehicle.

Advantages of chopper harvesters

- Chopper harvesters are complete combines and do not require separate infield loading equipment.

- Modern combine harvesters are able to handle both green and burnt cane in a wide range of weather and crop conditions, from erect to badly lodged cane.
- In pollution sensitive areas choppers harvesters have a distinct advantages because of their ability of handling green cane.
- The delay between harvest and crushing is minimal, resulting in higher sugar recoveries.
- Chopped cane feeds into the mill more easily and consistently.
- Chopped cane spillage en route to mills is usually lower than whole stalk.
- Labor requirement is reduced.

Disadvantages of chopper harvesters

- The high capital outlay makes this system appropriate only for large scale growers and contracting groups.
- Harvesting, transport and milling operations are linked, which means that communication and transport scheduling is vital to obtain optimum harvester utilization.
- Receiving facilities at mills that usually handle whole stalks would have to be adapted.
- Cane losses are generally higher compared with whole stick harvesting systems.
- Chopped cane deteriorates more quickly than whole stalks and ideally should be crushed within 12-14 hours after harvesting. This may increase transport costs.
- High levels of managerial/operator skill and technical support are required.

Manual harvesting of sugarcane

Mechanical harvesting of sugarcane

Tractor mounted sugarcane harvesters/cutters

Tractor attached sugar cane harvester/cutters may be front mounted, midway mounted or rear mounted. This harvesting system still requires an appreciable amount of labour as cane stalks have to be detrashed, detopped, bundled and subsequently, loaded into the wagons. Heavy recumbent cane is difficult to handle with these aids and dry leaves are removed only partially.

The tractor mounted cutter/harvester have to satisfied fallowing demands

I. Able to cut unburned cane of up to 100 tons per hectare.
II. Tolerant of rough and ready field preparation, able to cut from furrows, ridges, tied-furrows or flat-planting.
III. Able to work in stony conditions.
IV. Tolerant of variable row spacing and of wide Raton stools.
V. Able to negotiate difficult headlands, in-field ditches.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Metabolism of insecticides

Article id: 22875

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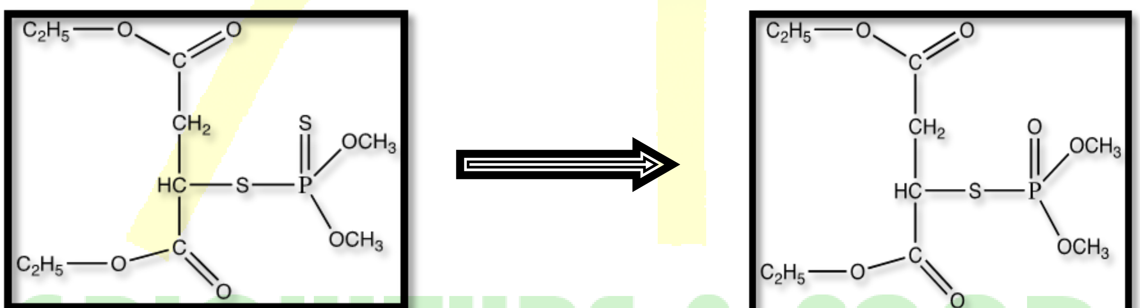
INTRODUCTION:

When an insecticide applied to any living organism (plant or animal), it undergoes some chemical changes resulting in the formation of new products called metabolites, and the process is known as metabolism. The metabolite is a greek word which means change; all insecticides get metabolized in plants, animals, soils and water to a varying degree. The extent and nature of the metabolites vary with the chemical, the organism, e.g. species, strain, age and sex, etc., the time and the environmental factors. If changes take place at more than one point of the molecule either by way of separate pathways or as sequential reactions, then a series of metabolites are formed. These metabolites may be more toxic, equitoxic or less toxic in comparison with the original compound. The metabolism of insecticides can be categorized into two broad groups, i.e. activation and detoxification.

Insecticides metabolism

1. Activation: activation can be defined as the metabolic reaction that converts an inactive compound to an active compound or an active compound to another active compound.



Ex: Structure of Malathion **Activated insect metabolite**

Metabolism of organophosphate insecticides

Insecticide		Enzyme	Activated metabolites
Dichlorvos	Reduction	Esterase	Glucorinide
	Demethylation	S-alkyl transferases	Inorganic phosphoric acid

Parathion	Oxidation, isomerisation	MFO	Paraxon
Malathion	Oxidation	Carboxylesterase	Malaxon
	De- alkylation		Desmethyl malathion
	Hydrolysis		Malathion monoacid& diacid
Dimethoa te	Hydrolysis	Phosphatase	Phosphoric acid derivatives
Demeton	Oxidation	Esterase	Sulfoxide, sulfone

Gupta, 1999

2. **Detoxification:** The metabolic reaction converts the compound into non-toxic compounds.

- Ex: Mosquito cytochrome P450 CYP6Zs in insecticide detoxification.

Detoxification mechanism of resistance to major insecticide groups

Detoxification by	**Insecticide group to which resistance evolved**
Carboxylesterases	Carbamates, organophosphates, pyrethroids.
Oliesterases	Organophosphates
Cytochrome p450/MFO	Carbamates, Ops, pyrethroids, neonicotinoids.
Glutathion S- transferases	Organochlorines, OPs, pyrethroids.
DDT dehydrochlorinases	DDT

Li *et al.,* 2007

The central role of mosquito cytochrome P450 CYP6Zs in insecticide detoxification

Detoxification enzymes such as cytochrome P450 monooxygenases (P450s or CYPs), GSTs and CCEs (carboxy/choline esterases) are known for their roles in insecticide metabolism in insects, and their overproduction has been frequently associated with resistance to chemical insecticides in mosquitoes (Chandor *et al.,* 2013).

Importance of insecticide metabolism studies

- ✓ Studies in mammals as metabolic predictors for man.
- ✓ Studies in animals and plants to evaluate the potential for residue occurrence in human foods.
- ✓ Studies to elucidate activation and detoxification phenomena and mode of action.
- ✓ Studies to evaluate effects on non-target organisms.
- ✓ Studies to define the metabolic basis for pesticide selectivity.
- ✓ Studies to satisfy regulatory requirements.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

- ✓ Studies to find out the role of various interactions for the persistence of pesticides
- ✓ Studies to help for generating data for fixing up tolerances.
- ✓ By understanding the metabolism helps to develop the medicines in a medical field.

Enzymes involved in metabolism

1. **Esterases:**
   - ✓ These are the enzymes which hydrolyze carboxylic and phosphorus esters.
   - ✓ Thus esterases abbreviated as est include the Oliesterases, phosphoryl phosphatase, paraoxonase and other enzymes hydrolysing phosphorus esters. It also consists of the di esterase.
2. **Mixed function oxidase or mfo system:**
   - ✓ This utilizes NADPH as a cofactor in enzymatic activation of molecular oxygen for eventual insertion into the substrate.
   - ✓ In mammals, these enzymes reside mainly in the endoplasmic reticulum or microsomal fraction of liver while in insects they are concentrated in the fat body, intestine and Malpighian tubules.

Metabolic Pathways:

I: Phase-I reactions

- a. **Oxidation:** Oxidation is taken place through mfo in which one atom of a molecule of oxygen is reduced to water while the other was used to oxidise the substrate.
- b. **Reduction**: A hydrogen atom replaces halogen. Ex: Conversion of DDT into DDD
- c. **Glutathion mediated reaction**: In the metabolic process of insecticide, glutathion is utilized either in a purely catalytic manner like conversion of DDT to DDE in houseflies or consumed by the direct binding to the substrate.
- d. **Hydrolytic process**: By the action of esterase enzymes, the positivity on the phosphorus atom of the insecticide was reduced.

Ex: Organophosphate insecticides hydrolysed by a phosphatase, carboxy esterase or carboxyamidases.

II. Phase-II reactions

Insecticides which are metabolised by conjugating reactions are categorised under phase-II reactions. These reactions may be:

- a. **Glutathion conjugation**: Wherein the harmful electrophilic compounds are conjugated with GSH (reduced glutathion) and other nucleophilic centres like proteins and nucleic acids are protected.

Ex: Ethyl parathion may be de-ethylated to form desethyl parathion or de-arylated to form dimethyl phosphoric acid.

- b. **Glucoside conjugation**: wherein the insecticides or their metabolites combine with glucose to form conjugates.
- c. **Amino acid conjugation:** Occurs by the activation of the insecticidal acid through the enzyme requiring ATP and the condensation after that with the endogenous amino acid.

CONCLUSION: Studies on insecticide metabolism leads to an understanding of how a particular insecticide acts, its selective toxicity (selectivity of insecticides to man and higher vertebrates), how it behaves in different ecosystems. It also helps in understanding the development of resistance in target organisms, how to handle the resistance by developing synergists, fixing of MRL values for both parent material and its metabolites. Environmental hazards are of major concern are minimized with the understanding of insecticide metabolism ways.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Metabolic resistance in insects

Article id: 22876

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INTRODUCTION:

Resistant insects detoxify or destroy the toxin much faster than susceptible insects, or quickly rid their bodies of the toxic molecules. Metabolic resistance is the most common type and often presents the most significant challenge. Insects use their internal enzyme systems to break down insecticides. Resistant strains may possess higher levels or more efficient forms of these enzymes. In addition to being more active, these enzyme systems also may have a broad spectrum of activity, *i.e.,* they can degrade many different insecticides (IRAC, 2011).

The enzymatic metabolism of insect is modified to increase insecticide detoxification or prevent activation of insecticides.

- Metabolic resistance – through detoxification by increased activity of specific enzymes/ conversion of insecticides to non-toxic metabolites or prevent activation of insecticides
- The most prevalent type of resistance is developed in insects by converting the pesticides into metabolites which are non-toxic (Detoxification)
- These non-toxic breakdown products can be excreted or stored in the body without doing any harm to the insects
- The detoxifying enzymes being present in large quantities in resistant strains (R) and absent or present only in minute amounts in susceptible (S) strains of insects
- The detoxifying enzymes are believed to be synthesized by the microsomes – membranous particles in the cytoplasm
- Endoplasmic reticulum has also been suggested to trap the toxins and render them non-toxic, thereby inducing resistance.

Metabolic resistance via detoxification

Most of the insecticides can be detoxified or inactivated by five main groups of enzymes:

- Esterases
- Oliesterases
- Cytochrome p450 mono-oxygenases
- Glutathion S-transferases (GSTs)
- DDT dehydrochlorinases

Esterases:

- As the early 1970s, hydrolases, especially the subgroup of esterases, were implicated in insecticide resistance
- Most detoxifications in insects are attributed to carboxylesterases, with a few rare cases catalyzed by arylesterases (aromatic esterases).

- Detoxification can be caused by increased esterase activity or amplification of a gene encoding the esterase gene.

Examples:

- ❖ Oxidation of malathion to malaxon was reported to an equal rate in both susceptible and resistant house flies, but malaxon is degraded more rapidly by the action of phosphatase in the resistant fly.
- ❖ In *Culex tarsalis,* the resistant larvae convert malathion to non-toxic metabolites by carboxylesterases at a much higher rate than susceptible larvae.

Agriculturally important Insect pests which were reported to poses elevated esterase–based resistance mechanisms

Sl. No	Inset
1	*Aphis gossipii* (Cotton Aphid)
2	*Bemisia tabaci* (Tobacco whitefly)
3	*Leptinotarsa decemlineata* (Colorado beetle)
4	*Lygus hesperus* (Plant bug)
5	*Myzus persicae* (Peach potato aphid)
6	*M. Nicotianae* (Tobacco aphid)
7	*Nilaparvata lugens* (BPH)
8	*Schizophis graminum* (Green bug)
9	*Scirtothrips citri* (Citrus thrips)

Oliesterases: are capable of breaking down many organophosphate compounds in insects.

Cytochrome p450 mono-oxygenases:

These enzymes are a critical metabolic system responsible in the detoxification of xenobiotics, and therefore an essential mechanism by which an insect species evolves insecticide resistance.

Over-expression of cytochrome P450 Monoxygenases in different insects

Gene	Insects	Resistance to
CYP6D1	*Musca domestica*	Pyrethroids
CYP6A1	*Musca domestica*	Cyclodines, OP, Carbamates
CYP6Z1	*Anopheles gambiae*	Pyrethroids
CYP6B2	*Helicoverpa*	Pyrethroids
CYP4G19	*Blatella germanica*	Pyrethroids
CYP6A2	*Drosophila melanogaster*	DDT
CYP6A9	*Drosophila melanogaster*	DDT

Glutathion S-transferases (GSTs):

- ✓ Increased Glutathion S-transferases in the resistant strains, reduced pyrethroid - induced lipid peroxidation and mortality.
- ✓ The elevated GSTs provide a significant mechanism for pyrethroid resistance in BPH.

DDT dehydrochlorinases:

- ✓ In DDT resistant house flies they detoxify the toxic DDT to non-toxic DDE by enzyme dehydrochlorinases. The high concentration of dehydrochlorinase found in the fat body and brain tissues.
- ✓ The occurrence of this enzyme in the fat body is very significant since the fat body in insects functions like a mammalian liver. Therefore, it is rich in the detoxifying enzyme.

Synergists preventing the detoxification of the insecticides

- All the synergists appear to work by blocking the detoxification of the insecticides with which they applied. They may also help in penetration and stabilization of the insecticides.
- Analogue synergists: which have a structural resemblance to the insecticides and compete with insecticides for the detoxifying enzyme site on the MFO system.
- Ex: DMC, F-DMC, chlorefenethol.
- Microsomal inhibitors: which inhibit or reduce the activity of the microsomal enzyme. As a result, the rate of detoxification of insecticides is reduced.
- Ex: Benzo-1,3-dioxoles, phthalimide.

Some of the synergists used with insecticides are

- Sesamin, sesamolin, piperonyl butoxide, sesamax, safrole, sulfoxide, propylisom, tropital, 2,3-methylenedioxy phenozine, piperonyl cyclonene, 2-3-methylene dioxynaphthalen, n-isobutyl undecycleneamide etc.

Inhibitors of MFO

- These are several groups of materials, typified by the benzo (d)-1,3-diaxoles which inhibit the oxidative metabolism associated with the microsomal enzyme system.
- Originally benzo (d)-1,3-diaxoles (methylenedioxy phenyl) compound was developed for use with the pyrethroid insecticides. Subsequently, several new groups of compounds which possess a similar spectrum of activity were formed.
- These include the aryloxyalkylamines (SKF 525-A), 2- prophynyl, oxime esters, organothio cyanates and other materials like N-(-5-pentynyl) penthalimide, phosphono esters containing proponyl functions (Regupathaya, 2003).

Inhibitors of esterases

- Compounds like EPN, TOCP, DEF, Triphenyl phosphate and others enhance the insecticidal activity of malathion to resistant strains of insects.
- The combination of malathion + iprobenfos (a fungicide) was used against resistant rice leafhopper.

- Monocrotophos, profenofos, acephate, methidathion some propynyl phosphates and phenyl saligenin cyclic phosphate inhibit pyrethroid esterases, by which they increase the insecticidal activity (Ishaaya and Cans, 1981).

CONCLUSION: In insects, metabolic resistance is the dominant type of resistance, hence by understanding these mechanisms and enzymes involved in detoxification helps to control the resistant population of insects by using suitable synergist along with insecticides.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Navigation Strategies in Desert Ants

Article id: 22877

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INTRODUCTION:

Orientation and navigation are almost as ancient as non-sessile animal life. Locomotion through the environment creates the need to orient, with regard to hospitable or dangerous places, with regard to food sources, predators and mates. Navigation becomes necessary when an animal returns to a particular place on an episodic or regular basis. This may be a shelter, a nest or a feeding site. Navigation thus requires a particular location to be remembered and tied into some form of spatial memory.

Orientation and memory capabilities for navigation have evolved several times, and probably independently, at least for more complex forms of navigation. Capable navigators occur among the chordates, especially in higher vertebrates, molluscs, especially the cephalopods, and in all major arthropod groups, including insects, crustaceans and chelicerates.

According to complexity and level of abstraction, navigation strategies can be sorted into three broad categories. Although other modes of categorization are possible and useful depending on the task at hand, the distinction of route following, path integration and map use serves the present purpose

Route Following:

Route following is perhaps the most straightforward mode of navigation, even if the route that is followed by an animal will usually not be straight at all. These routes are marked by trail pheromones, which are the only orientation cues available when a route is first established, but may be complemented by visual and mechanical cues once a trail has become firmly established as a major road, and cleared and perhaps straightened out. The broad roads of leaf cutter ants are a good example.

Routes for navigation may not just be marked by pheromones, however. The complementation of ant pheromone trails by visual and mechanical cues, possibly just collaterally, in cleared and firmly established ant roads has already been mentioned. Another common strategy in ants and other insects is the navigation along memorized sequences of visual ‘snapshots’ that define a trajectory for navigation. A possible disadvantage is that such a visually based path has to be learned individually and cannot be followed by novice ants, as can a pheromone trail. A possible advantage is that navigation safety may be increased. If a pheromone trail is interrupted accidentally, a lengthy search may be necessary to recover the open trail end. A series of snapshots or a memorized panorama or skyline course, by contrast, is more robust against local changes, such as a broken branch on a tree’s silhouette, or even a more distant toppled-over tree. A small interruption would probably not compromise navigation along the trail because the remaining memorized structures, even if distant, would attract the navigator into the original path (Basten and Mallot, 2010).

This is borne out by the foraging paths of the Australian desert ant *Melophorus bagoti* (Kohler and Wehner, 2005). This species usually lives in habitats where grass tussocks and small shrubs provide abundant landmarks – although somewhat uniformly shaped and distributed. The landmarks along the whole length of a repeatedly used foraging trail are memorised, such that the ant is always informed about its present position along the trail. This route memory is remarkably robust and dominates other navigation cues. The ant may be intercepted at any time, for instance, just before starting its return journey to the nest after it has collected a food item at a feeder [Fig. right: full-vector ant; feeder (F) established 10m from the nest (N)], or just before entering the nest with its food morsel (Fig. left: zero-vector ant). If the animal is placed anywhere along the memorised path between nest and feeder, it resumes its homebound journey immediately and is well oriented. This is indeed surprising because the ant was just a moment earlier confronted with the appropriate panorama and possible other stimuli signifying feeder or nest positions, respectively.

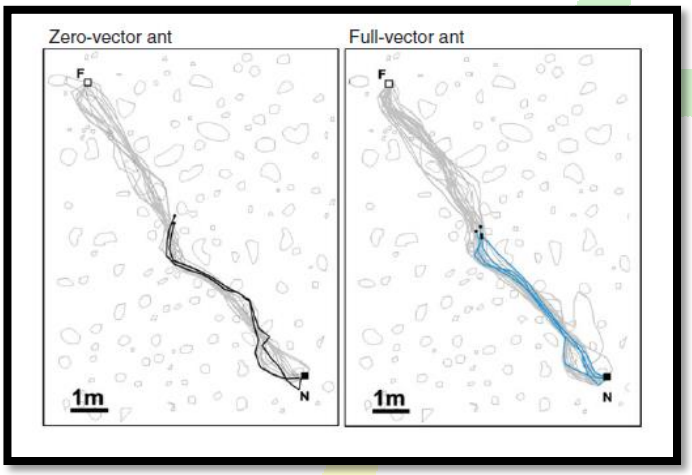


Figure. 1. Route following

Furthermore, this visual mode of route following is not the only means of navigation for *Melophorus*. The species also has a path integrator that constantly updates the animal's position relative to the nest, quite independent of any visual input. However, the visual mode of orientation completely overrides path integration in the above experiments, and path integration is evident only when the animals have to orient in an environment devoid of landmarks.

Path Integration:

Path integration, or dead reckoning, makes a navigator independent of a particular idiosyncratic route. It keeps an animal constantly informed about both direction and distance to a goal, and it may further allow optimisation of search and foraging strategies, independent of local orientation marks. Path integration has been studied in many animals, but with particular success in arthropods and, again, in ants. During an excursion from a home base, such as a foraging trip of an ant leaving its nest, direction and distance cues are constantly monitored. The animal has to combine the momentary progress along its trajectory with the total distance and direction to the nest reached so far, its 'home vector'. This is achieved by incremental vector summation of the previous home vector with the present increment in locomotion (Muller and Wehner, 1988). The summed increments in vector integration may correspond to the single strides of an animal (see below, and also Fig.).

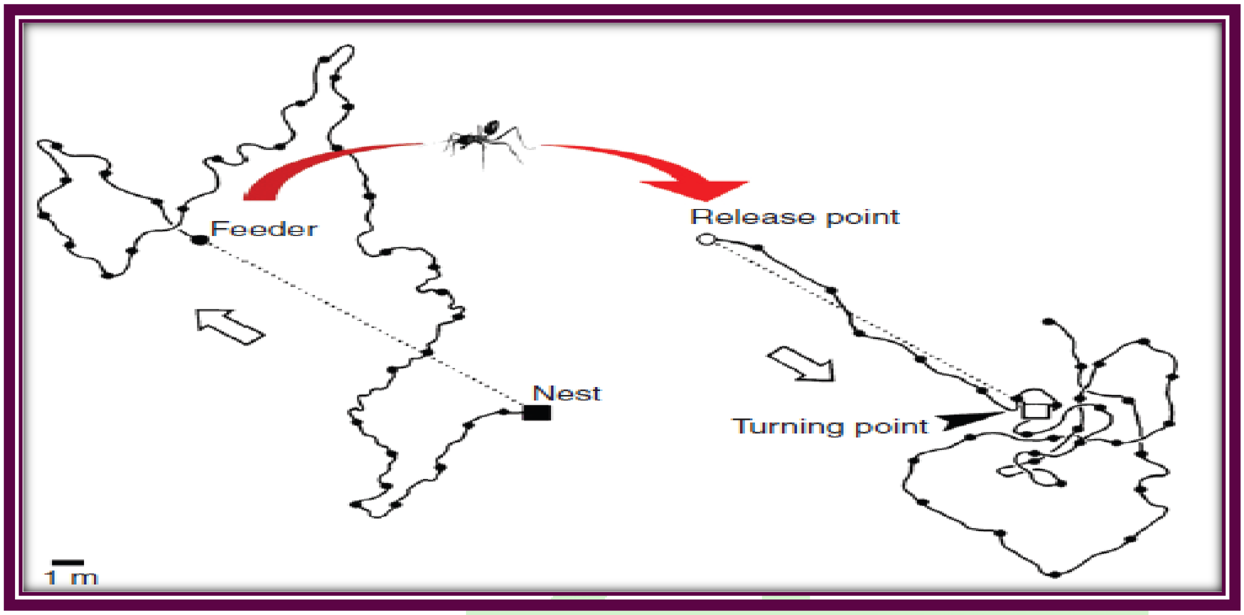
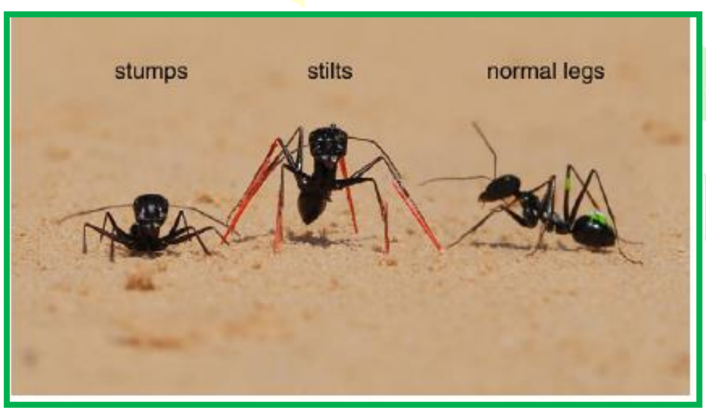


Figure 2: Path integration

Path integration thus makes an animal truly independent of external orientation cues, such as pheromone trails, landmarks, or terrain structure.

Odometry by Stride Integration:

Stride integration in desert ant odometry. *Cataglyphis fortis* ants were trained to collect food at a feeder located 10m from the nest. The animals were captured once they had collected a food item, and their leg lengths were manipulated. Their legs were either severed half way down the tibia, reducing stride length by approximately 30% ('stumps' on the left). Or the legs were extended by gluing stilts made from pig bristles to the tibiae, increasing stride length by more than 30% ('stilts' in the middle). A control group was handled but kept their normal leg lengths ('normal legs' on the right). The animals were supplied with a food item after the operation and released in a test channel to examine their homing distance, the end of which is reliably indicated by the start of nest searching behaviour (similar to Fig.). If they relied on a stride counter (and with possible other means of distance measurement eliminated) one would thus expect the ants returning on stumps to underestimate the distance to the nest by approximately 30%. By the same token, the ants on stilts should overestimate homing distance by more than 30%. At the same time, they would disprove the argument that the ants on stumps ran short just because they were disabled; stilts actually impair walking behaviour more than do stumps. And the control ants should home reliably over 10m before searching for the nest. And this is indeed close to what was observed in the



experiments. However, one has to consider that stride length changes also under normal circumstances, in conjunction with stride frequency.

If an insect carries a load or walks slowly for any other reason it takes shorter strides, and strides are longer in fast running, and stride frequency changes accordingly (as is true for virtually all animals walking on legs). And the above manipulations of leg lengths, and in particular the additional load of the stilts, as well as the food items to be carried, indeed reduced walking speed and thus stride frequency. It is therefore not stride number that is counted; rather, the strides an animal's takes are summed considering both their length and their number – they are integrated, hence the term stride integrator. This can be verified when normalising the stride lengths actually observed in the manipulated ants (via high-speed video recording) with the changes in stride frequency brought about by the load that is carried.

Another parameter that might be used for odometry is optic flow, which avoids the problem introduced by varying loads. Optic flow, the movement of the external world across the retina of the eye during self motion, is a reliable indicator of the direction, the velocity and, after integration over time, of the distance of travel. Odometry by optic flow has been demonstrated by a set of elegant experiments in honey bees refuting the then prevailing idea of odometry by energy consumption. Honey bee uses optic flow for their navigation; not only this strategy but also they utilize direct sun light, polarized light from sun, Energy consumption and bee dance for knowing the direction and distance.

Map-like spatial representations

Maps are familiar to humans from everyday use, be it hiking or long distance travel. These maps provide a bird eye's view of the terrain, based on the cartographic concept of representing points and routes in a primarily two-dimensional space. Biologists refer to this idea of maps, although there is no common terminology in detail. The term 'map' is often used to imply that the animals under study, including humans, possess a spatial representation similar to a cartographic map.

The assembly of landmarks and local and global vectors into a two-dimensional spatial arrangement would thus yield a map-like orientation capacity – as opposed to the mere local association of landmarks, snapshot sequences and local vectors along a route or along a global vector path. The use of such true maps has been suggested in honey bees (Menzel *et al*., 2005).

CONCLUSION:

Insects are not true astronavigators; some other mechanisms like magnetic field, wind direction, geographical positions *etc* also used by insects for their navigation. First, true astronavigation as defined above-establishing a fix by purely astronomical means-is beyond the insect's capacities and those of the pigeon, and has not been demonstrated in any animal species. It would require not only the sensory capacity to detect and localize the relevant celestial cues, and an extremely precise chronometer always synchronized with local time at home, but also a set of rules by which the daily, seasonal, and geographical variations of skylight patterns could be handled and used. With respect to both space and time, insects are bound to more local problems.

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Natueco Farming: Thinking beyond Organic Farming

Article id: 22878

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INTRODUCTION:

In the Natueco Science concept, farming is seeing as a precise science influenced by very precise natural cycles as the moon and the sun except rain water. So, Natueco Science use farming logical based on the scientific thought far from all occultism and reproducing natural phenomena. The farming work is considered as an intensify reproduction of natural cycles using human intelligence. In the nature, there is no watering, no adding of fertilizers or any kind of pesticides. The objective of Natueco Science is to optimize the two principles natural factors which are influencing the development of the vegetation and extra canopy: the harvesting of the sunlight by the leaves and the wealth of the soil. The clever farming system in the way to optimize these two main factors is possible to create a naturally productive plot in a small scale of time. Where, the nature need hundreds of years to create a productive forest, Natueco Science proposes alternative solutions to reach the same level of production in only few months.

Natueco Farming-Philosophy:

Dabholkar (2001) coined the word "Natueco" that combines two words together, Natural and ecological. Natueco has been conceived of as a holistic way to meet our farming and food requirements. It addresses serious issues of a farm, like (i) staying in synergy with Nature, (ii) reducing dependency on external inputs to a farm, and (iii) working scientically within the available resources in the surroundings of a farm, without harming its ecology and at the same time gaining high benets from it. According to Dabholkar, the features of Natueco culture distinguish it from the Natural Farming and/or Organic Farming; and he calls it 'Beyond Organic Farming'. He explains that Natural or Organic farming is done trusting Nature through the empirical wisdom of the ages. In Natueco Farming, however, farming is done by knowing Nature better through critical scientific inquiries and experimentation.

Natueco Farming emphasizes 'Neighborhood Resource Enrichment' by 'Additive Regeneration' rather than through dependence on external, commercial inputs. The four relevant aspects of Natueco Farming are as below:

1. **Soil**: Focus on enrichment of soil by recycling the biomass and by establishing a proper energy chain.
2. **Roots**: Focus on development and maintenance of white root zones of the plant for efficient absorption of nutrients.
3. **Canopy**: Focus on harvesting the sun through proper plant canopy management for efficient photosynthesis.

4. **External resources**: Focus on minimizing the use of external resources including water.

Key Features of Natueco Farming Science:

1. Plants are grown on small heaps of Amrut Mitti (nectary soil), the Natueco process of building fertile soil covered with mulch, hence no ploughing. Amrut Mitti is the key ingredient a compost in the form of heaps that are always kept moist.
2. Need based sowing and harvesting of crops.
3. Does not need any external input in terms of the agro-chemicals.
4. High diversity on a small piece of land over 125 crop species with a mix of annuals and perennials.
5. Trenches around the farm for rain water harvesting.
6. Live fencing around each farm created for multiple purposes.

Amrutjal (nectary water) is prepared by mixing 10 liters of water, 1 liter of cow urine, 1 kg of fresh cow dung, and 50 grams of jaggery. Ferment this mixture for 3 days, stirring it well twice or thrice each day. On the 4th day, the concentrated suspension is ready. One part of this suspension is diluted to ten parts with water. Amrut Mitti is prepared from green and dry plant biomass, both are dried and crushed well. The dried biomass is immersed in Amrutjal in a container and then kept as such for 24 hours (Nene, 2017). Dabholkar's Natueco method was popularized by Suchde (2011), who explains that it is possible to create a micro-climate to assure self-sufciency. It follows the principles of nature's ecosystem in our farming systems and emphasizes harvesting through a critical application of scientific inquiries and experiments that are rooted in the local resources.

Understanding about Natueco Farming Science:

- Natueco Farming methods go beyond natural farming and organic farming.
- In natural farming, farming is done trusting nature through the empirical wisdom of ages. However, Natueco methods emphasize farming by knowing nature more and more through critical scientific inquiries and experiments. It is an ever growing, novel, unique, participatory tryst between man and nature. Moreover, Natueco Farming in no way related to the present commercial techniques of farming.
- It has a new vision of infinite resource potentials in Nature and sunlight and promises plenty for all through harvesting all available resources by increasing the human activity.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Innovative - Ornamental Flower Pots

Article id: 22879
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INTRODUCTION

This is an innovative and well – known dried flower pot, which is made by coloring dried leaves of papal and dried fruit of bottle gourd, then after being made, it is done as the beauty and decoration of a place. Pots can be prepared easily in very cheap and accessible form.

Fig: 1 Pipal Leave

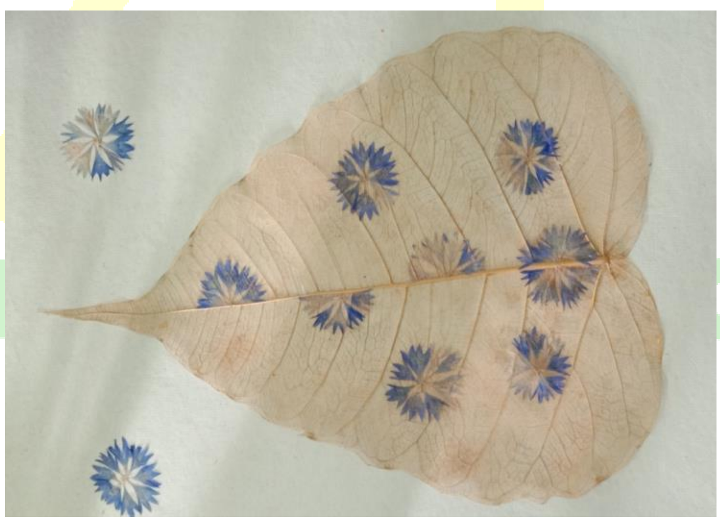

Fig: 2 Pipal leave

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Required Material

1. Fresh pipal leaves
2. Normal water
3. Wooden Brush
4. Colour
5. Bamboo spike
6. Stick of leaves
7. Artificial bottle pots
8. Blue gum

Steps

1. Selection of fresh peepal leaves (10-20 leaves)
2. To keep the normal water (deep) - 15-20 days
3. Changing of water per days
4. Removal of algae in leaves
5. Cleaning of water
6. Drying of leaves
7. Coloring of leaves and bottle pots
8. Joining of bamboo spike stick in bottle pots
9. Stick of leaves in bamboo spike

Fig: 3 (a) Ornamental pots

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Fig: 4 (b) Ornamental pots

Procedures

To make ornamental flower pots, first take 10-20 fresh pipal leaves, then keep it in normal water 15-20 days should be changed every day after that, algae and dust from the leaves surface generally remove it from the surface, then clean water leaves with clean water of tub and dry it, after that, color the dried leaves and dried bottle gourd fruit with color, after that ornamental flower pots from the bamboo stick through gum to the dry colored leaves of the people after his bamboo stick that becomes a beautiful ornamental flower pots.

Advantages

1. It's used for table decoration
2. It lasts almost indefinitely.
3. To keep a long duration
4. To generate employment
5. For exhibition
6. It is not depend on season or weather if once good materials are collected.

CONCLUSION

You can improve our standard of living by making the ornamental flower pots easily rural at the least time and expense and also get employment at a small level. In this way, the ornamental flower a pot is also decorates for the beauty of the small place.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Polyamine Function and Role in Abiotic Stress Responses

Article id: 22880

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Polyamines (PAs) are low molecular weight aliphatic nitrogenous bases containing two or more amino groups. They are widely distributed in eukaryotic and prokaryotic cells. They play important roles in diverse plant growth such as flower development, embryogenesis, organogenesis, senescence, and fruit maturation and developmental processes. PAs are play important role in cell division, cell proliferation and differentiation, cell death, DNA and protein synthesis and gene expression and have antioxidant properties. They are also involved in responses to biotic and abiotic stresses. Putrescine (Put), spermidine (Spd), and spermine (Spm), thermospermine (Tspm) and cadaverine (Cad) are the main PAs in plants**.** They are considered as a new kind of plant biostimulant. PAs improve plant's growth and productivity, and to provide a basis for future research on the mechanism of action of PAs in plant growth and development.

Polyamines are synthesized from the amino acid, arginine and converted into ornithine which will be converted to putrescine catalysed by the enzyme ornithine decarboxylase (ODC). Further to that, putrescine is converted to spermidine by spermidine synthase while spermidine is synthesized to spermine by spermine synthase. The synthesis of polyamine declines with age due to the decline in enzyme catalysing the reactions. Polyamines show tissue- and organ-specific distribution patterns in plants. For example, the most abundant PAs in leaves was found to be Put, and its levels were three times higher than those of Spd and Spm, whereas Spd was found to be the most abundant PAs in other organs.

The polyamine metabolism is connected to several important hormonal and metabolic pathways involved in development, stress responses, nitrogen assimilation and respiratory metabolism. Polyamine and ethylene biosynthesis are connected through SAM that acts as a common precursor. Antagonistic effects between these compounds occur during leaf and flower senescence, and fruit ripening. Polyamines induce the production of nitric oxide (NO) that may act as a link between polyamine mediated stress responses and other stress mediators.

Pas functions in tolerance and/or amelioration of stress in plants-

(i) PAs are serving as compatible solutes along with Pro, glycine-betaine and GABA;
(ii) Its interactions with macromolecules like DNA, RNA, transcriptional and translational complexes, and cellular and organellar membranes to stabilize them
(iii) Its role in directly scavenging oxygen and hydroxyl radicals and promoting the production of antioxidant enzymes and metabolites

(iv) PAs act in gas signal molecules in the ABA-regulated stress response pathway and through the production of H_2O_2
(v) Its regulators of several ion channels
(vi) PAs also participation in programmed cell death.
(vii) Its play important role in metabolic regulation of ammonia toxicity, nitric oxide (NO) production, and balancing organic N metabolism in the cell.

Polyamine accumulation occurs in response to several adverse environmental conditions, including salinity, drought, hypoxia, chilling, heat, ozone, UV-B and UV-C, heavy metal toxicity, mechanical wounding and herbicide treatment. The physiological implication of these responses remained unclear, and it had to be evaluated whether elevated polyamine levels were a result of stress-induced injury or a protective response to abiotic stress. Enhanced abiotic tolerance always correlated with raised levels of Put and/or Spd and Spm. Up-regulation of PAs biosynthesis in plants through transgene expression generally increases their tolerance to a variety of stresses. Using exogenous polyamine application also shows similar results and inhibitors of enzymes involved in polyamine biosynthesis, pointed to a possible role of these compounds in plant adaptation to several environmental stresses.

Polyamines, ROS (H_2O_2) and NO act synergistically in promoting ABA responses in guard cells. Polyamines are reported to promote the production of NO in Arabidopsis. Like ABA signalling pathway in stomata regulation which involves many different components such as ABA receptors, G-proteins, protein kinases and phosphatases, transcription factors and secondary messengers, including Ca^{2+}, reactive oxygen species (ROS) and NO; polyamines such as Put, Spd and Spm also regulate stomatal responses. In this regard, evidences point to an interplay between polyamines with ROS generation and NO signalling in ABA-mediated stress responses. The generation of ROS is tightly linked to polyamine catabolic processes, since amino oxidases generate H_2O_2, which is a ROS associated with plant defence and abiotic stress responses. ROS are capable of causing widespread damage to a variety of cellular metabolites as well as macromolecules. Increase in ROS production in stress tolerant plants is often accompanied by increased biosynthesis of antioxidants and associated antioxidant enzymes to ameliorate the ROS from cellular environment. The role of PAs in augmenting antioxidant based defense systems to impart tolerance against drought, heat, salt, heavy metals, UV and other stresses that are potent inducers of superoxide molecules causing oxidative damage to the living cells have been reported in several studies. Antioxidant enzymes can scavenge ROS to prevent membrane lipid peroxidation and stabilize membrane structure. Polyamines (Spm, Spd, and Put) can regulate the size of the potassium channel and the size of pores in the plasma membrane of guard cells, thereby strongly regulating pore opening and closing. Put treatment was shown to improve seed germination and increase all growth indexes like hypocotyl length, root and shoot fresh and dry mass.

CONCLUSION: The relationship between PAs and plant growth, development and stress tolerance are tightly linked. Roles of PAs in plant growth and developmental processes ranging

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from germination to flowering and flowering to senescence, are well discussed in various studies. Its also play important role in abiotic stress tolerant by enhancement the level of antioxidant metabolism.

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AGRICULTURE & FOOD: e- Newsletter
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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Innovative - Ornamental Bina

Article id: 22881

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INTRODUCTION

Ornamental bina is a most popular valion instruments in our Indian country which is used as different festival and celebration of various auspicious days of human. Bina or ornamental bina is a type of violin which is use for beautification and decoration of any any room/ hotel /parks or college. The bina is easily prepare of dry 'Tumba' & 'Loaki' means round and long bottle gourd.

Fig. 1: Ornamental Bina (A) angle

Fig 2: Ornamental Bina (B) angle

Fig. 3: Head of Ornamental Bina

Materials

1.) Round (Tumba) & Loaki (long) Bottle gourd
2.) Seed Cleaning brush
3.) Fabrication color
4.) Blue gum (stick)
5.) Paper flower
6.) Taat (roap)
7.) Deep stick (Length)
8.) Peacock wing and
9.) Hoop, bell wood (left & right) etc.

Preparation step

1. Sun drying
2. Cleaning of seed
3. Joining of Tumba & Loaki for good shape
4. Coloring of fabric color
5. Blue gum
6. Paper flower
7. Taat roap
8. Deep stick
9. Peacock wing
10. Hoop (bell wood) left & right

Procedures

1. First we have to collect a fresh bottle gourd then sun dried it.
2. Second we have to dried after cleaning a seed through brush.
3. After cleaning the seed then joining the dry Tumba & Loaki for good violin shape
4. Then coloring of fabric color in shape of violin
5. After color of valion to stick a blue gum in Tumba & Loaki
6. After stick the blue gum then keep paper flower

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

7. Then tied the taat (roap) of violin for voice
8. After tied the taat to deep stick in long prepare vaiolin
9. And second last point to stick a peacock wing
10. After use a peacock wing then tied a bell wood for tied a taat roap

Advantage of Ornamental Bina

7. Its used for violin instruments
8. Its used for beautification & decoration of any area
9. Its used for human freshener
10. It is use as value addition
11. To generate employment
12. For exhibition

CONCLUSION

Ornamental Bina is a most popular and easily prepare Tumba & Loaki violin instruments which is cheaply prepared in our Indian people for their beautification and decoration of the home. Bina is manmade instrument. It is locally available material for prepare of the ornamental violin Bina.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Endophytic bacteria and its establishment in host plant

Article id: 22882

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INTRODUCTION

Endophytic bacteria are those bacteria that colonize the internal tissues of the plant without causing any harm to the plant. The term "Endophyte" is derived from two Greek words "Endon" which means within and "Phyton" which means plant.

Every plant on the earth is a host to at least one (or) more endophytes. Endophytic bacteria primarily enter into the host plant through root zone, they may be either localized or spread through the entire plant. Bacterial endophytes share same ecological niche as that of plant pathogens, which makes them suitable for biological control (Ryan *et al*., 2008). Endophytic bacteria form associations such as symbiotic, mutualistic and trophobiotic relationships (Momota *et al*., 2012). Bacterial endophytes synthesize bioactive compounds that stimulate the plant growth and also increase resistance to plant pathogens (Rosenblueth and Martinez-Romero, 2006).

ESTABLISHMENT OF ENDOPHYTIC BACTERIA BY THE HOST PLANT

The recruitment of bacterial endophytes by the host plant involves three phases.

I. **Attachment of endophytic bacteria to the host plant:**

The bacteria swim towards the roots using chemotactic signals from root exudates and attach to the root. Flagella and fimbriae helps in attachment, and exopolysaccharides (EPS) synthesized by bacterial cells also facilitate attachment of bacterial cells to root surface.

Exopolysaccharides produced by the endophytic bacteria *Gluconacetobacterdiazotrophicus*Pa15 was an essential factor for attachment to root surface and colonization. The EPS shielded the bacterial cells from oxidative damage. In *Herbaspirillum senopedicae,* an endophytic bacterium in maize, Lipopolysaccharide (LPS) is essential for attachment. Binding of N-acetyl glucosamine of LPS with lectins on surface of maize root is required for colonization.

II. **Entry of the endophytic bacteria into the host plant:** Natural cracks at the lateral root emergence sites are the most entry sites for endophytic bacteria. They may also enter through stomata, wounds and hydathodes.

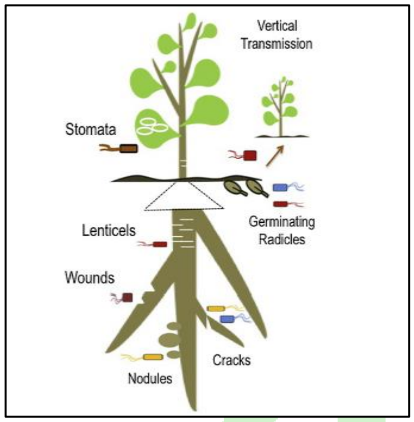


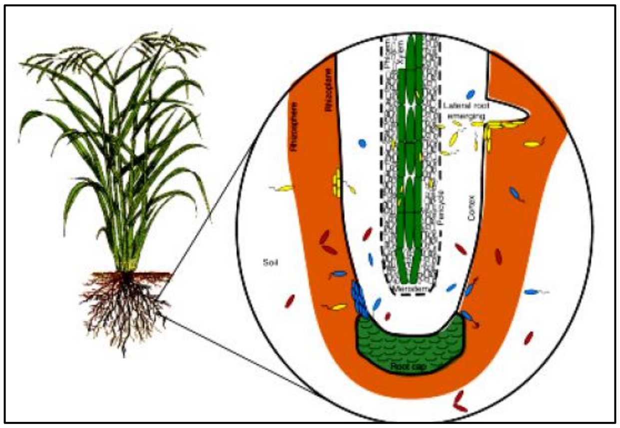
Fig 1: Entry sites for Endophytic bacteria

Seed endophytes gain entry from vegetative parts of the plant to the seed through the vascular connections/ through gametes directly colonising the embryo and endosperm. Vertical transmission i.e. transfer from parent to offspring has also been reported in seed endophytes. It is possible in two ways: i) the bacteria exit the seeds and then enter the plants through other places on plant surface. ii) Bacteria remain inside the seed and spread through the plant/ move within the plant tissue.

III. **Colonization of the host by the bacterial endophyte:** Endophytic bacteria colonise in the intercellular spaces due to abundance of carbohydrates, amino acids and inorganic nutrients. endophytes were first observed in root hairs and subsequently in root cortex.

The mobility of bacterial cells accompanied with synthesis of cellulolytic enzymes help the spread of bacterial endophytes to the aerial plant parts. For examples, endoglucanases are essential for *Azoarcus* sp. to colonize rice roots. *Arabidopsis thaliana* selectively recruits the bacterial endophyte *Bacillus subtilis* FB17 by secretion of malic acid. EB are also know to colonize, by secreting cell wall degrading enzymes or through rhizophagy. Rhizophagy is a phenomena certain plants actively bring microbes in the soil into their cells, in order to digest them and acquire essential nutrients from them.

Based on their colonization, bacterial endophytes are of three types: Passenger endophytes, Opportunistic endophytes and competent endophytes. Soil inhabiting bacteria might become endophytic by chance through colonization of natural wounds or through invasion by nematodes. Endophytes which colonize root cortex and are known as passenger endophytes. Opportunistic endophytes show particular root colonization characteristics such as a chemotactic response, which enables them to colonize rhizoplane and then invade the internal plant tissues through the cracks. Competent endophytes successfully colonize a plant by actively entering plant tissue and have a capacity to modulate plant physiology which leads to beneficial maintenance of plant-microbe association.



Red Cells - Passenger Endophytes
Blue Cells- Opportunistic Endophytes
Yellow Cells- Competent Endophytes

Fig 2: Types of Endophytes (Sascha et al., 2014)

CONCLUSION:

Endophytic bacteria are useful in enhancing plant growth ability, and it can be used for plant disease control which is an unfocused part of research that to be given importance. These can be called as plant beneficial organisms, which strive inside the plants and improves plant growth under normal and challenging conditions by enhancing nutrient uptake and also by regulating growth and stress related phytohormones.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Effect of drought on stream insects and its ecological consequences

Article id: 22883

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INTRODUCTION

- Drought is defined as extended period (seasons to years) of deficit precipitation compared to the statistical long term average in a region.
- Types of Drought: 1) Meteorological drought 2) Hydrological drought and 3) Groundwater drought. Drought can also be classified as seasonal and supraseasonal drought.
- Stream insects play central ecological roles in virtually all running waters and are vital for flood plain and riparian food webs, processing organic matter and transporting energy along stream channels, vertically down into the stream bed and even laterally to the flood plains.
- In forest streams aquatic insects break down leaf litter, supplying nutrients, carbon and energy to the stream and associated ecosystems.
- Activities can alter water quality and influence energy flow patterns in different trophic levels
- Biological interactions often have significant effects on community structure.
- So, their diversity, distribution and assemblage are routinely assessed as an indicator of the 'health' of running waters (Boulton and Lake 2008).

Functional feeding groups

- Functional feeding groups varied across the gradient of the stream.
- Different functional feeding groups such as shredders (caddisfly and cranefly larvae), scrapers (caddisfly and mayfly larvae), collector-gatherers (stonefly larvae) and predators (water beetles) have important roles in stream nutrient cycling.
- In recent years, functional feeding groups have been used as bio-indicator and bio-monitoring organisms.
- Presence of pollution intolerant insect orders like Ephemeroptera (*Isonychia* sp., *Clypeocanis* sp., *Petersulla* sp. *and Isca* sp.), Trichoptera (*Helicopsyche*), indicate the good quality of river water,
- Whereas, pollution tolerant species like *Baetis* (mayfly) and *Hydropsyche* (caddisfly) that indicate poor quality of river water (Balachandran *et al*., 2012).

Impacts of Drought on Stream insects

- Sequential losses of hydrological connectivity
- Loss of lateral connectivity
- Loss of longitudinal connectivity
- Shrinking pools and "predator soup"
- Refuge use in dry stream bed

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Ecological Consequences of Progressive Loss of Stream Insects during Drought

- Organic matter processing and carbon transfer
- Food web dynamics
- Aquatic- terrestrial linkages
- Indirect effects of drought

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Scope of biological control of new invasive pest fall armyworm in INDIA

Article id: 22884

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1. INTRODUCTION

In nature, the population of any organism is regulated. It is kept fluctuating within an upper and lower threshold, often below economically damaging levels, due to the actions of biotic regulations (availability of food, parasites, predators, and/or pathogens) and/or abiotic factors (climate and soil factors). Such population regulation is referred to as natural control. However, such natural control when disrupted due to biological, anthropogenic, or climatic factors results in the outbreak of organisms leading to economic damage. Invasiveness of a pest species into new geographies in the absence of biotic regulatory factors often results in the disruption of natural control, leading to devastating outbreaks (*e.g.*, fall armyworm (FAW), *Spodoptera frugiperda* [J.E. Smith]; tomato leaf miner, *Tuta absoluta* [Meyrick]). Anthropogenic changes in crop and pest management practices such as introduction of a susceptible crop/cultivar, monocropping, and irrational use of broad-spectrum pesticides, among others, also often result in disruption of natural control, leading to outbreaks of pest and diseases. Asynchrony in range expansion of pests and their natural enemies due to climate change could also disrupt the natural control.

The best approach to manage such outbreaks is to either revive or establish natural control as much as possible. Biological control primarily focuses on restoring the natural control. Biological control, as defined by Paul DeBach (1964), is the action of living organisms (parasites, predators, or pathogens) introduced by human intervention for regulating the population of another organism at densities less than those that would occur in their absence. Parasitoids are biological agents for which at least one of their life stages is intimately associated with specific life stages of the pest and with greater levels of specificity (*e.g.*, parasitoid species belonging to *Trichogramma* and *Telenomus* parasitizing eggs of insects including FAW). The larvae of parasitoids always kill their host as the outcome of their development. Predators, on the other hand, are never intimately associated with the insect pest, and the pest serves as prey for the predator often with less specificity (*e.g.*, insects such as ladybird beetles, earwigs, and sap sucking insects such as *Orius* and *Podisus* prey on various life stages of FAW). Entomopathogens include bacteria, fungi, protozoans, nematodes, or viruses that infects and causes diseases in insects (*e.g.*, fungi such as *Metarhizium anisopliae* and *Beauveria bassiana;* viruses such as *Spodoptera frugiperda* multiple nucleopolyhedrovirus (SfMNPV); and bacteria such as *Bacillus thuringiensis* (*Bt*), and others that are known to infect FAW) Prasanna, et al (2018); FAO and CABI (2019).

1.1 Biocontrol-based IPM Strategies for FAW

FAW is native to the Americas and a newly introduced pest species in India. As is common with invasive species, most of the naturally occurring biocontrol agents for this pest are not present, or native species have not yet adapted to this new host or prey. Implementation of any IPM strategy in India for FAW control should seek to avoid disrupting biocontrol processes that are operational for other pests and those that are adapting to FAW. Conservation of the diversity and density of natural enemies should be a key focus in such a strategy. A simple way to achieve this is to provide, near the maize area, conditions conducive to survival of natural control agents. Planting crops that provide shelter, alternative food sources, and conditions for multiplication of beneficial species may be key to regulating the FAW population. At the edges of maize cultivation areas, rows of crops such as Mexican sunflower or Crotalaria might be suitable components in landscape management with the goal of increasing the biodiversity of beneficial insects, even those that are not yet associated with FAW. A "Push-Pull" strategy can also be used, in which pest-repellent plant species are intercropped with the main crop to repel ("push") pests out of the field, which is also surrounded by a border of a pest-attractive species to "pull" both the pest and beneficial insects into it

The second step in the implementation of a biocontrol-based IPM strategy against FAW is to assess the economic injury levels (EIL); strengthen monitoring, scouting, and surveillance efforts; and undertake pest management efforts through inundative release of natural enemies or through application of biorational pesticides, such as botanicals, or biopesticides, especially when the pest density exceeds EIL.

1.2 Advantages of Using Biological Control of FAW in India

Biological control, especially classical and conservation biological control, is much cheaper and benefits smallholder production systems in India. Further there are no cases of resistance development among FAW to biological control agents as pest is new to Indian agro-ecosystem. With effective capacity building initiatives, India can take advantage of the available manpower, such as farmers' associations, to mass-produce and release biological control agents for FAW management in India. List of bio-agents identified on the FAW in India presented in the table-1.

Table-1: Natural enemies of *Spodoptera frugiperda* in India ecosystem

S.No.	Scientific name	Family	Host stage	References
1	*Telenomus* sp.	Hymenoptera: Platygastridae	Egg parasitoid	Shylesha,et al. 2018
2	*Trichogramma sp*	Hymenoptera: Trichogrammatidae	Egg parasitoid	
3	*Glyptapanteles creatonoti* (Viereck)	Hymenoptrea: Braconidae	Larval parasitoid	
4	*Forficula sp.*	Dermaptera: Forficulidae	Larval predator	

5	*Coccygidium melleum* (Roman)	Hymenoptera: Braconidae	Endo larval parasitoid	Sharanabasappa, et al. 2019
6	*Campoletis chlorideae* Uchida	Hymenoptera: Ichneumonidae	Endo larval parasitoid	
7	*Eriborus* sp	Hymenoptera: Ichneumonidae	Endo larval parasitoid	
8	*Odontepyris* sp.	Hymenoptera: Bethylidae	Larval parasitoid	
9	*Exorista sorbillans* (Wiedemann)	Diptera: Tachinidae	Endo larval parasitoid	
10	*Forficula* sp.	Dermaptera: Forficulidae	Predator	
11	*Harmonia octomaculata* (Fabricius)	Coleoptera: Coccinellidae	Predator	
12	*Coccinella transversalis* Fabricius	Coleoptera: Coccinellidae	Predator	
13	*Nomuraea rileyi* (Farlow) Samson	Ascomycota: Clavicipitaceae	Entomo-pathogen on larva	
14	Nucleopolyhedrovirus (NPV)	Baculoviridae	Virus on larva	Raghunandan, et al. 2019

II. CONCLUSION

Based on the global experience of managing maize pests, biocontrol will serve as a necessary pillar of the IPM strategy for control of FAW in India. However, to harness this potential, it is important to assess the diversity and effectiveness of biocontrol species in India. Further, taking stock of the diversity of FAW biological control agents in India, selection of appropriate candidate agents for classical biological control of FAW in India based on ecological suitability assessments needs to be undertaken. Effective biorational pesticides that can aid in the management of FAW and conservation of natural enemies need to be identified and promoted. Preliminary assessments of biocontrol species on the continent suggest we should optimize the role of biocontrol in helping to manage FAW.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Deforestation and its effects: An overview

Article id: 22885

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INTRODUCTION

Increasing the world population and growing faster at a pace hard to match, the increasing need for space is turning out to be an area of concern. With desperate need for land for agricultural, industrial and most importantly urban needs to contain cities and their growing population, a direct action that we have come to recognize as "Deforestation" occurs. Deforestation in simple term means the felling and clearing of forest cover or tree plantations in order to accommodate agricultural, industrial or urban use. It involves permanent end of forest cover to make that land available for residential, commercial or industrial purpose. Over the last century the forest cover around the globe has been greatly compromised, leaving the green cover down to an all time low of about 30 per cent. According to the United Nations Food and Agriculture Organization (FAO), an estimated 18 million acres (7.3 million hectares) of forest are lost each year. Deforestation can also be seen as removal of forests leading to several imbalances ecologically and environmentally. Deforestation or clearance occurs due to several reasons, to get an overview we could include the need of money, both in terms of profitability as well as providing for one's family in most scenarios, along with lack of or no forest laws, need for land space for housing etc among a long list of other uses. Mainly blamed on agricultural or pastoral use, farmers cut trees for increasing space for cultivation or as fodder land for grazing and surviving live stock. The whole concept of 'slash and burn' agriculture is used to indicate this same process where farmers employ the above chain of actions for their purposes.

Deforestation?

Deforestation is defined as the permanent removal of trees to make something besides forest. This can include clearing the land for agriculture or grazing, or using the timber for fuel, construction or manufacturing.

Causes of Deforestation

1. **Agricultural Activities:** As earlier mentioned in the overview, agricultural activities are one of the major factors affecting deforestation. Due to overgrowing demand for food products, huge amount of tress are fell down to grow crops and for cattle grazing.
2. **Logging:** Apart from this, wood-based industries like paper, match-sticks, furniture etc also need a substantial amount of wood supply. Wood is used as fuel both directly and indirectly,

e-ISSN: 2581 - 8317 **Volume 2 – Issue 2 – February 2020**

therefore trees are chopped for supplies. Firewood and charcoal are examples of wood being used as fuel. Some of these industries thrive on illegal wood cutting and felling of trees.

3. **Urbanization:** Further on order to gain access to these forests, the construction of roads are undertaken; here again trees are chopped to create roads. Overpopulation too directly affects forest covers, as with the expansion of cities more land is needed to establish housing and settlements. Therefore forest land is reclaimed.
4. **Desertification of Land:** Some of the other factors that lead to deforestation are also part natural and part anthropogenic like Desertification of land. It occurs due to land abuse making it unfit for growth of trees. Many industries in petrochemicals release their wastes into rivers which results in soil erosion and make it unfit to grow plants and trees.
5. **Mining:** Oil and coal mining require considerable amount of forest land. Apart from this, roads and highways have to be built to make way for trucks and other equipment. The waste that comes out from mining pollutes the environment and affects the nearby species.
6. **Fires:** Another example would be forest blazes; Hundreds of trees are lost each year due to forest fires in various portions of the world. This happens due to extreme warm summers and milder winters. Fires, whether causes by man or nature results in huge loss of forest cover.

Effects of Deforestation

a. **Climate Imbalance:** Deforestation also affects the climate in more than one ways. Trees release water vapour in the air, which is compromised on with the lack of trees. Trees also provide the required shade that keeps the soil moist. This leads to the imbalance in the atmospheric temperature further making conditions for the ecology difficult. Flora and fauna across the world are accustomed to their habitat. This hazard clearance of forests has forced several of these animals to shift from their native environment. Due to this several species are finding it difficult to survive or adapt to new habitats.

b. **Increase in Global Warming:** Trees play a major role in controlling global warming. The trees utilize the green house gases, restoring the balance in the atmosphere. With constant deforestation the ratio of green house gases in the atmosphere has increased, adding to our global warming woes.

c. **Soil Erosion:** Also due to the shade of trees the soil remains moist. With the clearance of tree cover, the soil is directly exposed to the sun, making it dry.

d. **Floods:** When it rains, trees absorb and store large amount of water with the help of their roots. When they are cut down, the flow of water is disrupted and leads to floods in some areas and droughts in other.

e. **Wildlife Extinction:** Due to massive felling down of trees, various species of animals are lost. They lose their habitat and forced to move to new location. Some of them are even pushed to extinction. Our world has lost so many species of plants and animals in last couple of decades.

Measures to Control Deforestation

- **Reduce Population Growth and Increase Per Capita Incomes:** Reduction of population growth is pivotal in reducing deforestation in the developing countries. Consequent of reduced population, increase in per capita income will occur as a consequence of increased incomes and

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

literacy rates which will reduce pressure on the remaining forests for new human settlement and land use change.

- **Reducing Emissions From Deforestation and Forest Degradation:** Many international organizations including the United Nations and the World Bank have begun to develop programmes to curb deforestation mainly through Reducing Emissions from Deforestation and Forest Degradation (REDD) which use direct monetary or other incentives to encourage developing countries to limit and/or roll back deforestation.
- **Increase the Area and Standard of Management of Protected Areas:** The provision of protected areas is fundamental in any attempt to conserve biodiversity. Protected areas alone, however, are not sufficient to conserve biodiversity. They should be considered alongside, and as part of, a wider strategy to conserve biodiversity. The minimum area of forest to be protected is generally considered to be 10 per cent of total forest area. It is reported that 12.4 per cent of the world's forest are located within protected areas. Tropical and temperate forests have the highest proportions of their forests in protected areas and boreal forests have the least.
- **Increase the Area of Forest Permanently Reserved for Timber Production:** The most serious impediment to sustainable forest management is the lack of dedicated forests specifically set aside for timber production. If the forest does not have a dedicated long-term tenure for timber production then there is no incentive to care for the long-term interests of the forest. FAO (2001) found that 89 per cent of forests in industrialized countries were under some form of management but only about six per cent were in developing countries.
- **Increase the Perceived and Actual Value of Forests:** There are several ways of achieving increasing the perceived and actual value of forests. Governments can impose realistic prices on stumpage and forest rent and can invest in improving the sustainable productivity of the forest. National and international beneficiaries of the environmental services of forests have to pay for such services. There has been some success in devising schemes to collect payments for environmental services like carbon sequestration, biodiversity conservation, catchment protection and Deforestation: Causes, Effects and Control Strategies of ecotourism.
- **Promote Sustainable Management:** In order to promote sustainable forest management, it must be sustainable ecologically, economically and socially. Achieving ecological sustainability means that the ecological values of the forest must not be degraded and if possible they should be improved. This means that silviculture and management should not reduce biodiversity, soil erosion should be controlled, soil fertility should not be lost, water quality on and off site should be maintained and that forest health and vitality should be safeguarded. However, management for environmental services alone is not economically and socially sustainable.
- **Encouraging Substitutes:** For all purposes where tropical or other timber is used, other woods or materials could be substituted. We can stop using timber and urge others to do the same. As long there is a market for wood products, trees will continue to be cut down.
- **Increase Area of Forest Plantation**: Increasing the area of forest plantations by using vacant or unused lands and waste and marginal lands especially as road side, along railway tracts, on contours, avenues, boundaries and on land not suited for agricultural production should have a

net positive benefit. Planting trees outside forest areas will reduce pressure on forests for timber, fodder and fuel wood demands. Moreover the deforested areas need to be reforested.

- **Participatory Forest Management and Rights:** In frontier areas much of the forest is nominally owned by the state, but the reach of government and the rule of law are weak and property rights insecure. For forest management to succeed at the forest frontier, all parties with an interest in the fate of the forest should be communally involved in planning, management and profit sharing. But forest ownership and management rights are almost always restricted and restrictions on ownership and use define alternative tenure systems.
- **Support and Reforms:** Aid organizations like the World Bank have traditionally favoured spectacular large-scale development al projects. In all cases when such projects are proposed there has been a massive opposition from local people. Reducing the demand for southern-produced agribusiness crops and alleviating the pressure from externally-financed development projects and assistance is the essential first/primary step. Campaigns opposing such developments and the campaigns to reform the large aid agencies which fund such schemes should be supported. Local campaigns against specific mining, dams, industrial and tourist developments should be supported.
- **Increase Investment in Research, Education and Extension:** Training and education of stakeholder's helps people understand how to prevent and reduce adverse environmental effects associated with deforestation and forestry activities and take appropriate action when possible. Research substantiates it and helps to understand the problem, its cause and mitigation. This arena is lagging behind for paucity of funds and investments encourages this arena. There is a lack of knowledge and information in the general community about forests and forestry. Forest managers and those developing forest policies need to be comprehensively educated and need to appreciate the complexity of the interacting ecological, economical, social, cultural and political factors involved.
- **Improve the Information Base and Monitoring:** Information on the global distribution of biodiversity and forest poverty is inadequate. Knowledge of how much forest, where it is and what it is composed of seems to be straight forward but surprisingly this most basic information is not always available. It is not possible to properly manage a forest ecosystem without first understanding it. New remote sensing technologies make it feasible and affordable to identify hotspots of deforestation.
- **Policy, Legislative and Regulatory Measures Enforcement and Compliance:** A wide variety of policy statements and legislative and regulatory measures have been established to protect forests but need to be effectively enforced. New modifications adjustments are of course needed for site specific conditions. Laws, policy and legislation should be such that they encourages local people and institutional participation in forestry management and conservation along with safeguarding indigenous people's traditional rights and tenure with rightful sharing of benefits. Many formal and informal enforcement/compliance mechanisms are used to prevent deforestation and environmental problems from forestry activities. These approaches include negotiation, warnings, cancelling work orders, notices of violation, fines, arrests and court action.

CONCLUSION

Deforestation is an important issue to be discussed. It has adverse effect on each living beings life. Deforestation has become a huge concern in today's life as there has been a rise in the decline of forests. Trees are cut down in order to manufacture paper based products as well as for livestock farming and so on. In other hand economic globalization combined with increasing global land scarcity and land use change. In a more interconnected world, agricultural intensification may cause more rather than less cropland expansion. The apparent trade between forest and agriculture can be minimized through Managemental aspects. This can be further addressed by community based forest management which builds on political goodwill and strong community institutions, and reforestation is the solution, which has to be implemented by the government sector and it has to be promoted and implemented from grass root level starting from village panchayats, schools, colleges and all publics sector premises. New challenges from climate change require urgent action to explore and protect the local value of forests for livelihood even more.

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Disease of honey bee and its management

Article id: 22886

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1. INTRODUCTION

Beekeeping is an interesting hobby, an ideal agro-based subsidiary enterprise, providing supplementary and sometimes major income to the people in the rural areas. The diverse fauna of honeybees occurring in India further enhances its practical utility. Although seven species of Apis have been described but India is a unique country where the four *Apis* species of major importance are now present. These include two wild species viz. *Apis dorsata* (Giant / Rock honey bee or dumna) & *A. florea* (small honey bee) and two domesticated species viz. *A. cerana* (oriental honey bee) and *A. mellifera* (occidental or European honey bee). The first three species are indigenous, while the fourth one is an exotic introduction in the country. Like all other living creatures, honey bees also suffer from several diseases and are attacked by different enemies.. The diseases in brood and adult honey bees are caused by bacteria, fungi, viruses, rickettsiae and protozoa. In India, brood diseases such as American foul brood, European foul brood, Thai sac brood and adult bee diseases viz. acarine, nosema and clustering disease have been reported in Asiatic hive bee, *Apis cerana* Feb. European honey bee, *Apis mellifera* Linnaeus have been reported to suffer from European foul brood, sac brood and chalk brood diseases. Bees have two distinct life forms (brood and adult) and most diseases are specific to either one stage or the other but the most virulent diseases are those of the brood.

2. BACTERIAL DISEASES

A. American foulbrood disease (AFB):

Beekeepers in temperate and sub-tropical regions around the world generally regard American foulbrood (AFB) as possibly the most destructive microbial disease affecting bee brood. The disease did not originate in, nor is it confined to, the Americas. It is widely distributed wherever colonies of *Apis mellifera* are kept. In tropical Asia, where sunlight is abundant and temperatures are relatively high throughout the year, the disease seldom causes severe damage to beekeeping operations. The disease is contagious and the pathogenic bacterium can remain dormant for as much as and more than 50 years.

Cause:

American foulbrood is a bee larvae affecting disease and is caused by *Paenibacillus* larvae. In U.S. it is the most destructive of all bee diseases.

- The pathogen is a rod-shaped, flagellate, motile bacillus highly resistant to heat, desiccation and disinfectants.
- Larvae of workers, drones and queens are all infected through ingestion of spores with their food. At the initial stage of colony infection, only a few dead older larvae or pupae will be observed.

- Subsequently, if remedial action is not taken, the disease will spread within the colony and can quickly spread to other colonies in the apiary as a result of robbing, drifting workers, or contamination caused by the beekeeper's hive manipulations.
- In the same way the pathogen agent can spread to other apiaries. Natural transfer mainly takes place within a radius of 1 km around the apiary. Often spores enter the bee colonies via foreign honey.

Symptoms:

- At death, the diseased larva changes from a normal pearly white color to a creamy brown, then gradually darkens.
- When a match-stick is thrust into the cell of the decomposed pupa, it draws out a ropy thread of several centimeters in length .
- As the larva dries up, it becomes dark brown or black, rather rough scale that lies uniformly on the lower side of the cell. These scales stick very tightly to the cell wall and can be removed only with great difficulty.
- The decomposed brood has an unpleasant smell.
- The normal convex cell cap becomes moist, dark and sunken, and later perforate. The perforation of the capped cells is the result of the attempt by the workers to uncap it to remove the decomposing remains.
- The brood combs of an affected colony become patchy in appearance, owing to the presence of the intermixed diseased and healthy

Stretch test

A simple way of determining whether AFB caused the death of the brood is the ‘stretch test’. A small stick, match or toothpick is inserted into the body of the decayed larva and then gently and slowly, withdrawn. If the disease is present, the dead larva will adhere to the tip of the stick, stretching for up to 2.5 cm before breaking and snapping back in a somewhat elastic way. This symptom called **‘ropiness’**, confirms American foulbrood disease, but it can be observed in decaying brood only.

B. European foulbrood disease (EFB)

This disease was first reported in 1885 from U.K. in *Apis mellifera* and India in 1970 from Maharashtra. The range of distribution of European foulbrood disease is not confined to Europe alone and the disease is found in all continents where *Apis mellifera* colonies are kept. *A. cerana* colonies are also subject to EFB infection. The damage inflicted on honey bee colonies by the disease is variable.

Symptoms:

- Honey bee larvae killed by EFB are younger than those killed by AFB. The diseased larvae die when they are four to five days old, or in the coiled stage.
- The colour of the larva changes as it decays from shiny white to pale yellow and then to brown. When dry, the scales of larvae killed by EFB, in contrast to AFB scales, do not adhere to the cell walls and can be removed with ease.
- The texture of the scales is rubbery rather than brittle, as with AFB. A sour odour can be detected from the decayed larvae.

- The clinical picture and the odour can vary depending on the kind of other bacteria involved (*Bacillus alvei, Streptococcus faecalis, Achromobacter eurydice*).
- Another symptom that is characteristic of EFB is that most of the affected larvae die before their cells are capped. The sick larvae appear somewhat displaced in the cells.
- When a scattered pattern of sealed and unsealed brood is observed in a diseased colony, this is normally an indication that the colony has reached a serious stage of infection and may be significantly weakened.

Control:

- Sterilize the combs and other hive parts with Formalin @ 150 ml/ l water, for 48 h at 43oC in fumigation chambers.
- Sterilize the combs with ethylene oxide @ 1 g/l for 48 h at 43°C in fumigation chambers
- Breeding disease resistant strains of bees is one of the best measures for the disease management.
- Burning of colonies including swarm shook coupled with provisioning of either brood alone or brood + pollen combs from the healthy colony is effective in controlling the disease. This method is commonly followed in European countries.

3. FUNGAL DISEASES

Two fungal diseases are important *viz.* **Chalk brood and stone brood**

C. Chalk Brood

This disease is caused by spore-forming fungus, *Ascosphaera apis.* The spores of fungus remain viable for years. The disease is most prevalent in the spring when the brood area is expanding, and the weather is still cool and there are not enough nurse bees to maintain the brood nest temperature. Its endemic infection is damaging otherwise it is a less serious disease. It affects only the brood. Brood cells can be sealed or unsealed. Workers, drones, and queens are all susceptible to the disease. Three - four days old larvae and those on periphery of brood area are more susceptible.

Symptoms

- Diseased larvae are stretched out in their cells in an upright position. Larvae dead from chalk brood disease are chalk-white and are often covered with cottony filaments, hence the name "chalk brood".
- Sometimes the diseased larvae can be mottled with brown or black spots, especially on the ventral sides. The white coloration may eventually give way to a gray or black, depending on the life stage of the fungus.
- Chalk brood mummies once dry, are loose in the cell, and can be removed easily. Often, a few of these mummies are visible on the ground at the entrance to the hive.
- The disease is transmitted by spores that are readily moved from colony to colony on infected pollen, robbing bees, drifting bees, or beekeeping equipment.

D. Stone Brood

This disease is caused by *Aspergillus flavus* which causes mummification of the brood of a honey bee colony. The fungi are common soil inhabitants and are also pathogenic to other insects, birds and mammals.

Symptoms

- Its spores are ingested with food and germinate in the gut, growing rapidly to form a collar like ring near the head.
- After death the larvae turn black and become difficult to crush, hence the name "stone brood".
- Eventually the fungus erupts from the integument of the larva and forms a false skin.
- The affected adult bees show restlessness, feebleness and paralysis, abdomen gets dilated and then mummified.
- Younger bees die earlier.

Management of Fungal Diseases

- There is no chemical control.
- Removal of mummies by bees results in natural control of the diseases.
- Collect and burn the mummified larvae.
- Improve ventilation and reduce humidity.
- Replace old, blackened brood combs as these may harbor chalkbrood spores.
- If a colony lacks sufficient food stores, supplement with good-quality feed.
- Replace queens with stock bred for hygienic behavior and/or disease resistance.

4. VIRAL DISEASES

Many viral diseases of honeybees are known but the extent and severity of different viruses vary. The bee viruses appear to be species specific. Three viruses, *viz.* Apis irridescent virus, Thai sac brood virus and Kashmir bee virus have been reported from India. Out of these three, the first two have been devastating *Apis cerana indica* in some parts of the country. Virus has been reported from India. Out of these three, the first two have been devastating *Apis cerana indica* in some parts of the country.

E. Thai sac brood virus

This viral disease was first detected in India in *Apis cerana indica* in Meghalaya in 1978 (Kshirsagar *et·al.,* 1982). The causative virus multiplies in adults which transmit the virus to larvae. Trophallaxis, swarms and drifting are believed to be the reasons of spread 'of the disease. Exchange of brood combs in between the_colonies is the reason of spread within thi apiary. Sac brood disease which is closely related virus disease in many other countries is not considered serious but Thai sac brood took up to 95% toll of Indian honeybee colonies during early eighties in northern India. The disease occurred with similar severity in south India during 1991-92.

Symptoms

- Brood die in pre-pupa but in unsealed stage
- Dead larvae straighten out and lie on their backs, with tip of the head capsule turned upwards.
- Dead pre-pupae turn into sac like structure
- Affected larvae are yellow or greyish, laterdarkening to blackish; the change in colour first starts from mouth parts and head.

- Dead larvae and pre-pupae dry up in brood cells forming loose scales.

F. Apis iridescent virus

This viral disease was reported from north-western states of India in seventies. The virus is specific to *A. cerana indica* and even in mixed apiaries the disease does not appear in *A. mellifera.* It forms crystals in tissues where the virus multiplies. The crystals appear bright blue-violet or green when observed under microscope with incident light. This is also revealed even with hand lens, or in sunlight with the naked eye. The virus multiplies in the fat bodies and other tissues of adult bees.

Symptoms

- Infected bees form clusters on the inside and later on the outside walls of the hive, hence it is also called as 'clustering disease'.
- Many crawling bees are found on the ground.
- Worker bees stop foraging, sit listlessly and even brood rearing is stopped.
- Queen stops egg laying and the eggs laid are not attended by nurse bees.
- Death of the entire colony follows.

G. Kashmir bee virus

The virus was first isolated from diseased samples of *A. cerana indica* from Kashmir. Strains of Kashmir bee virus have also been found in *Apis mellifera* in Australia. All stages of development die in the affected colony. The virus is transmitted by injection or even by contact of body surface and death is fast.

Bee viruses not found in India

There are several viruses found infecting *Apis mellifera* in other countries but not yet reported from India. Now *A. mellifera* is established in India and is fast spreading, therefore, any of the diseases known in the West can appear in India too in future.

Sac brood virus infected larvae fail to pupate and lie stretched on their back with head turned upwards. The larva becomes sac-like because fluid is filled in between the new integument and the unshed skin. Colour of the larva turns pale-yellow and finally becomes dark brown; the darkening start from the head region. The virus multiplies in hypopharyngeal glands of adult bees.

H. Paralysis virus

The infected bees have trembling motion of wings and bodies. They are unable to fly, crawl on the ground and bees become dysentric. There is no particular season of the year for viral infection but overcrowding is suggested to enha nce infestation,

I. Black queen cell virus

Infected queen larvae tum yellow and resemble sacbrood infected laIVae. The queen cell tips become black.

J. Bee Virus X and Y

Cloudy wing particle and Acute Bee Paralysis are other viral diseases of *A. mellifera*

Control

- For viral pathogens, there is no chemical control.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

- Affected colonies should be isolated beyond their flight range.
- Adopt all the management operations to keep colonies strong.
- Provide proper ventilation to reduce humidity.
- Cage the queen for a week and then requeen.
- Use sterilized equipments / combs.
- Check robbing, drifting and swarming.
- Provide supplement feeding.
- Undertake selective breeding for natural resistance.

4. PROTOZOAN DISEASE

K. Adult Bee Diseases

The diseases of adult bees are caused by protozoa which are single celled animals and form spores or cysts. They multiply by sexual or asexual methods. Their infection reduces vitality of bees, and shortens their life and fecundity. Protozoan is perfect parasites as they do not kill the host immediately. These diseases are difficult to diagnose, though inability to fly, unhooked wings and dysentery can be treated as general symptoms of an unhealthy bee. Microscopic examination is often necessary for a definite diagnosis.

L. Nosema Disease

This disease is caused by *Nosema apis* Zander. It is disease of adult bees. It parasitizes all the castes. Their spores germinate in the ventriculus of the host. Pathogen multiplies in epithilial cells and it checks RNA synthesis in the host cells. Its spores are shed in lumen of digestive tract of the affected bee and are then excreted out. One affected bee may contain 180 million spores. Hypopharyngeal glands of the diseased bee are atrophied. Colony strength dwindles down. Infection spreads through ingestion of fecal matter with contaminated food.

Symptoms

- Bees start foraging at younger age.
- Bees feel fatigued, are less able to fly and fall down during their return journey.
- Bees crawl up the grass blades and fall down on the ground and such affected fatigued bees gather in depressions / ditches.
- Abdomen is distended with fecal matter.
- Body hairs are lost and bees become shiny.
- Mid intestine is swollen and if dissected, shows dull greyish white contents.
- Bees soil the hive entrance.

Management:

- Provide fresh running water. Drain off stagnant water from the apiary.
- While transporting queens, select healthy attendant bees.
- Provide upward ventilation to reduce humidity.
- Feed fumagillin in concentrated syrup. It inhibits DNA replication of the pathogen.
- Disinfect the empty hives with ethylene oxide or acetic acid fumigation @ 120 ml / hive.

M. Amoeba Disease

- It is caused by *Malpighamoeba mellifecae*. This infection is caused by ingesting the cysts along with contaminated food. Cysts germinate, amoeba migrate to malpighian tubes and feed on cell contents. Amoebae multiply by binary fission and form cysts within 18-28 days of ingestion. Cysts accumulate in the mid-gut / rectum. Cysts are shed in the intestine and are excreted out with the fecal matter. Peak infestation occurs during April-May. Spring dwindling of colony strength can be experienced in such case.

Management:

- Ensure proper hygienic conditions.
- Scarp off the bottom board and disinfect it with 2% carbolic acid.
- Disinfection of hives and equipments with acetic acid is also helpful.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Insect venom, functions and possible uses

Article id: 22887

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INTRODUCTION

Venom is a poisonous fluid produced by animals such as snakes, spiders, scorpions and insects, that is injected into another organism using a specialized apparatus attached to a venom-producing gland. It may be used to immobilize or kill prey and/or to defend the delivering organism against attack by predators. Venomous insects belong to the orders Lepidoptera, Hemiptera, and Hymenoptera (Blum, 1981). Method of delivery may be active, such as mouthparts of Hemiptera (stylets), the sting apparatus of Hymenoptera (bees and wasps),or passive such as the modified setae/hairs in some lepidopteran larvae (caterpillars) that are broken on contact and pierce the outer surface of the receiving organism (Meyer, 1996).

The biological activity of the venom can be classified as neurotoxic, haemolytic (destroy cells), vesicating (blisters-producing), hemorrhagic (prevent blood from clotting) and algogenic (pain-producing) and are chemically consisting of alkaloids, terpenes, polysaccharides, biogenic amines (histamine), organic acids (formic acid) and amino acids, but the majority are peptides and proteins (Schmidt, 1986). Venoms containing peptide component from social Hymenoptera are spread over the molar mass range of 1400 to 7000 kDa and together comprise up to 70 per cent of the weight of freeze-dried Hymenoptera venoms (Palma *et al.,* 2006). These peptides generally account for cell lysis, haemolysis, antibiosis, and sometimes promote the delivery of cellular activators/mediators.

Most Toxic Insect Venom ?

- Harvester ants in the genus *Pogonomyrmex* have the most toxic venom based on mice LD_{50} values with *Pogonomyrmex maricopa* venom being most toxic.
- The LD_{50} value for this species is 0.12 mg/kg injected intravenously in mice, equivalent to 12 stings killing a 2 kg rat
- A *Pogonomyrmex* sp. sting produces intense pain in human that lasts up to 4 hour

Insect venom peptides

Honeybee (*Apis mellifera*)	Melittin, Apamin, Secapin, Tertiapin, Mast cell degranulating peptide (MCD)
Bumble bee	Bombolitins
Social wasps	Mastoparns, Chemotactic peptides, Kinnin related peptides, Sylverin, Crabrolin
Solitary wasps	Bradykinnin related peptides, Pompilidoxin ($PMTX_S$), Eumenine mastoparan-AF (EMP-AF), Anoplin
Ants	“Myr p” peptides, Pilosulin, Poneratoxins, Ponerecins, Ectatomin

Major constituent of bee venom and their activities

Peptides	Melittin	Hemolytic and Cytolytic activity
	Apamin	Neurotoxic activity block potassium channel
	MCD peptide (Mast cell degranulation)	Induce release of more histamine and more allergic reactions
Enzymes	Phospholipase A	Block biological function of membrane, Inhibit blood coagulation and decrease blood pressure.
	Hyaluronidase	Cause spread of inflammation
	Acid phosphatase	Allergic reactions
	Protease	Tissue necrosis
Amines	Dopamine	Increase pulse rate
	Histamine	Allergic hypersensitivity and inflammation
	Norepinephrine	Increase pulse rate

Insect Venom Allergy

Allergic reactions can be classified as local or generalised.

a) Local reactions- Local reactions involve oedema at the site of the sting. This comes on over several hours and varies in size, it can affect a hand or even an entire limb, this also leads to blistering and sometimes secondary infection.

b) Generalised reactions- Generalised (or systemic) reactions vary greatly in severity. Early features are pruritus and erythema, followed by urticaria and facial or generalised angio-oedema. In severe reactions it leads to hypotension which cause lightheadedness, fainting, giddiness, or loss of consciousness. Other features include abdominal pain, incontinence, central chest pain, or visual disturbances.

Functions and Biological roles of venom

- **Capture of prey**
- **Defence against competitors and predators**
- **Host parasite interaction** –The effect of Habrobracon hebetor venom on the activity of the prophenoloxidase system, the generation of reactive oxygen species and encapsulation in the haemolymph of Galleria mellonella larvae (Kryukova *et al*., 2011).
- **Manipulation of host physiology** – Virus like particles in the venom of *Meteorus pulchricornis* induce host haemocyte apoptosis (Suzuki and Tanaka, 2006).
- **Attractant** -Venom alkaloids and alarm pheromone of the fire ant, *Solenopsis invicta* act in concert to attract phorid flies, *Pseudacteon* spp. (Sharma and Fadamiro, 2010).
- **Neurotoxin**
  1) Venoms of Hymenoptera are blockers of the synaptic transmission. Examples are the presynaptic block by the proteins *Microbracon toxin A and B, the presynaptic* depletion by threonine-6-bradykinin and the postsynaptic block by the philanthotoxins. Ant toxin, poneratoxin, also effects the excitability of insect axons (Piek, 1990).
  2) Several peptides found in insect venom, including melittin, apamin and mastoparan, inhibit calmodulin activity (Barnette *et al.,* 1983)

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- **Venom peptides as feeding disorder** -Venom peptides from solitary hunting wasps induce feeding disorder in lepidopteran larvae (Baek *et al*., 2010)
- **Alarm response**

1) The venoms of *Polistes exclamans and P. fuscatus* elicit alarm behavior and attract attacking wasps (Post *et al*., 1984)
2) *Polistes fuscatus* female possess sex pheromone in the venom gland and sac and attracts males from short distances (Post and Jeanne, 1983)
3) Saturated hydrocarbons and the formic acid are alarm pheromones in worker ants of the formicine ant *Formica rufa* (Jan Lofqvist, 1976)

- **Antimicrobial activity**

1) Venom from the endoparasitic wasp, *Pimpla hypochondriaca,* contain antibacterial and proteolytic activity against the Gram-negative bacteria *Escherichia coli and Xanthamonas campestris* (Dani *et al*., 2003)
2) Two antibacterial peptides, namely Dominulin A and B, are found on the cuticle and in the venom of social paper wasp (*Polistes dominulus)* female. (Turillazzi *et al*., 2006)

USES

1) Medical Application- Apitherapy with bee venom

Disease type	Application details
Arthritis	Both osteoarthritis and rheumatic arthritis
Disease of the Central and Peripheral nervous system (CNS,PNS)	Multiple sclerosis Alzheimer Parkinson Against lower back pain
Anti-cancer effects	Antitumor effects on ovary, hepatoma, prostate, bladder, melanoma and renal cancers cells
Anti-diabetic	Lowers Blood glucose and increase insulin secretion
Heart and blood system	Hypertension, Arteriosclerosis, Angina pectoris, Arrhythmia
Skin diseases	Eczema like dermatitis, psoriasis, Furunculosis, Healing of cicatrices, baldness
Other diseases	Opthalmology, Urology, Pulmonology,Otorinolaringology.

2) **Bee venom**: A possible cure for AIDS.
3) Bee venom used as cosmetics.
4) Venom Used as Bio-pesticides against insect pests **(**Toxicity of newly isolated piperideine alkaloid from the red imported fire ant, *Solenopsis invicta* against Green peach aphid, *Myzus persicae,* Rashid *et al.*, 2013)

CONCLUSION:

The insects of the order Hymenoptera (bees, wasps, and ants) already provide humans with copious benefits. In addition to this, bee venom can also treat a wide range of health problems. So, protecting them and restoring their ecosystem becomes even more important. An estimated 18 to 20 naturally occurring antibiotic, antiviral, anti-inflammatory and pain reducing compounds are found in the ensuing concoction. The effectiveness of peptides or proteins produced by bees, wasps and ants venom for insecticidal or growth-regulating activity is likely to be a promising area of future research for eco-friendly pest management strategies

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

The Food Security Challenges

Article id: 22888

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Food security occurs when all people are able to access enough safe and nutritious food to meet their requirements for a healthy life, in such a way the planet can sustain into the future. Global food security will remain a worldwide concern for the next 50 years and beyond. At present scenario, yield of crop has fallen in many areas due to various reasons like declining investments in research and infrastructure, as well as rising water scarcity. However, food security faces a number of challenges across both production and consumption which research will be essential to solve.

Now a day's most of the countries are suffering from dual burdens like hunger and under nutrition beside overweight and obesity, with one in three people across the globe currently suffering from some form of malnutrition. Indeed it is not unusual to find people with different forms of malnutrition living side-by-side in one country, in one community, or even in the same household.

The dominance rates of overweight, obesity and diet-related non-communicable diseases (NCDs) such as cardiovascular disease, stroke, certain cancers, are increasing in every region, in both developed and developing countries. Worldwide most of the people who are overweight or obese than underweight, with the two mutual accounting for more than half of the world population: a new normal. At the same time, around 795 million people suffer hunger on a daily basis and more than 2 billion people be deficient in essential micronutrients (*e.g*. iron, zinc, vitamin A), affecting their health and life expectancy. Nearly a quarter of all children aged under five today are stunted, with diminished physical and mental capacities, and less than one third of all young infants in 60 low and middle income countries meet the least nutritional diversity standards needed for growth. Climate change will only make things worse as elevated levels of CO_2 reduce the nutritional content of grains, tubers and legumes, affecting key nutrients such as zinc and iron. The estimated impact of under nutrition on gross domestic product (GDP) is 11% each year more than the yearly economic recession caused by the worldwide monetary crisis.

It has been estimated that we need to produce more food in the subsequently 35 years than we have ever produced in human history, given the projected increases in world population, and on the basis that rising incomes will continue to change diets. However, there is no new land for agriculture, with rising competition from urbanization (the world will be 70% urbanized by 2050), sea level rise reducing land availability, and the growing need for land for bio energy, carbon capture and storage (BECCS) to remove greenhouse gases (GHGs) from the atmosphere. This implies sustainable intensification of agriculture on the land that is available (*i.e.* produce more without expanding the agricultural area).

Food production is eventually dependent on other ecosystem services so it is essential that these are maintained. For example, near about 70% of all fresh water consumes agriculture sector, and produces around one third of all GHG emissions, and much influence to biodiversity loss and soil degradation (about 69% of agricultural land is degraded). If food demand continues to grow as projected, by 2050 it is predicted that we would need 120% more water, 42% more cropland, lose 14% additional forest, and results 77% more GHG emissions. It is clear that we will need to use every technology available, alongside best practice farming to sustainably increase production, but this has to be accompanied by changes to food requirement including actions on both consumption and waste.

The Paris Agreement commits signatories to keeping the increase in global average temperature to well below 2°C above pre-industrial levels, with an aim to limit the increase to 1.5°C. Emissions across all sectors therefore need to decrease by over 80% by 2050, with even greater reductions required for a 1.5°C target. It has been expected that on the present path, the food scheme will account for most of the GHG emissions budget for 2°C, leaving a minimum space for other sectors, and making it almost impossible to meet the Paris Agreement.
Gradual climate change will alter what can be grown and where, but the variability that makes up the average temperature and rainfall will lead to climatic shocks (heat waves, cold snaps, droughts and floods), significantly reducing yields. Our report estimates that the risk of these kinds of extreme weather events hitting multiple major breadbasket regions of the world at the same time could triple by 2040. This results in a loss of yield that is channeled downstream via market and policy responses into food price spikes, and in some cases civil unrest. Climate change can also alter the distribution and severity of pests and diseases in crops and livestock and has the potential for severe impacts on food production and animal welfare. In present scenario approximately one third of the global food produced for human consumption every year gets lost or wasted, whether early in crop production constraints like pests and diseases and post-harvest losses, or delayed in the supply chain at retail and consumption. This impacts on how much we might need to produce in the future. A major challenge understands how we can re-design the food system to be healthy, sustainable, and more resilient to climate change, helping to meet both the Sustainable Development Goals and the Paris Agreement.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Role of mycorrhiza in crop plants for salinity tolerance

Article id: 22889

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1. INTRODUCTION

Arbuscular mycorrhizal fungi (AMF) are associated with the roots of over 80 % terrestrial plant species (Smith and Read, 1997; Hejiden et al., 1998) including halophytes, hydrophytes and xerophytes. Biological processes like mycorrhizal application to alleviate salt stress will be a better option. AMF have been shown to promote plant growth and salinity tolerance. They promote salinity tolerance by employing various mechanisms, such as enhancing nutrient acquisition (Al-Karaki and Al-Raddad, 1997), producing plant growth hormones, improving rhizospheric and soil conditions (Lindermann, 1994), altering the physiological and biochemical properties of the host plant(Smith and Read, 1995) and defending roots against soil-borne pathogens (Dehne, 1982).

AMF can also improve host physiological processes like water absorption capacity of plants by increasing root hydraulic conductivity and favorably adjusting the osmotic balance and composition of carbohydrates (Rosendahl and Rosendahl, 1991; Al-Karaki and Clark, 1998; Ruiz-Lozano and Azc´on, 2000; Ruiz-Lozano, 2003). This may lead to increased plant growth and subsequent dilution of toxic ion effect (Juniper and Abbott, 1993). The alleviation of salt stress by AMF and its beneficial effects on growth, changes in biochemical, physiological and molecular mechanisms used by host plants to alleviate salt stress. The different mechanisms by which AMF symbiosis protects the plants against salt stress.

1.1 Changes in Plant with Mychorriza

1.1.1 Plant Growth and Biomass

Mycorrhization was found to increase the fitness of the host plant by enhancing its growth and biomass. Several researchers have reported that AMF-inoculated plants grow better than non-inoculated plants under salt stress (Giri *et al*., 2003; Sannazzaro et al., 2007; Zuccarini and Okurowska, 2008). It has been reported that mycorrhizal Acacia nilotica seedlings had higher root and shoot dry weight compare to non-mycorrhizal seedlings (Giri *et al*., 2007). Al-Karaki (2000) observed a higher shoot and root dry weight, fresh fruit yield, fruit weight and fruit number in a mycorrhizal tomato plant than in a non-mycorrhizal tomato plant (Colla *et al*., 2008) reported improved growth, yield, water status, nutrient content and quality of fruits of Cucurbita pepo plants colonized by Glomus intraradices when exposed to salinity stress.

6.1.2 Nutrient Uptake

AMF have a positive influence on the composition of mineral nutrients (especially poor mobility nutrients such as phosphorus) of plants grown in salt-stress conditions (Al-Karaki and Clark, 1998) by enhancing and/or selective uptake of nutrients. It is primarily regulated by the supply of nutrients to the root system (Giri and Mukerji, 2004) and increased transport (absorption and/or translocation) by AMF. Mycorrhizal dependency increases with increasing salt concentrations. It is found to vary with the isolates of fungus and species of plant (Tian *et al.,* 2004).

6.1.3 Nodulation and Nitrogen Fixation

Nodules, formed through symbiosis with nitrogen-fixing bacteria are considered as a soft target for salt stress and their occurrence decreased due to salt stress (Harisnaut *et al*., 2003; Rabie and Almadini, 2005; Garg and Manchanda, 2008). This is likely due to premature nodule senescence triggered by salt stress (Gogorcente *et al*., 1997; Gonzalez et al., 1998; Matamoros *et al.,* 1999) which causes an acceleration of lytic activities, formation of green pigments from leghaemoglobin and loss of nitrogen fixation (Delgado *et al.,* 1994).

AMF can counteract the harmful effects of salinity on nodulation and nitrogen fixation in legumes. The AM symbiosis could alleviate drought stress-induced premature nodule senescence (Ruiz-Lozano et al., 2001; Porcel *et al*., 2003). Giri and Mukerji (2004) reported a strong effect of mycorrhizal inoculation on nodule formation under salt stress. The colonization of a legume by AMF can increase the number of nodules. It is indicate a positive influence of AMF on legume–nitrogen-fixing bacteria symbiosis. Higher leghaemoglobin content was observed in mycorrhizal plants.

The leghaemoglobin content was determined by estimating the change of colour in the nodule from pink to brownish pink due to synthesis of green pigments from leghaemoglobin. This greening of nodule was observed much earlier in non-AM plants (8 weeks) than AM plants (10 weeks). Mycorrhizal plants also have higher nitrogenase activity. All these parameters contribute to the higher nitrogen-fixing ability of AM plants. This increased nitrogenase activity and nitrogen fixation in AM plants as opposed to non-AM plants has been attributed to relief from P stress, which is beneficial for the functioning of the nitrogenase enzyme of the bacterial symbionts and possibly due to uptake of some essential micro-nutrients which results in either improved growth of plants (Founoune *et al*., 2002) or vice versa.

Therefore it may be suggested that mycorrhizal and nodule symbioses often act synergistically on infection rate, mineral nutrition and plant growth which supports the need for both N and P and increased tolerance of plants to salinity stress (Rabie and Almadini, 2005).

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e-ISSN: 2581 - 8317
Volume 2 – Issue 2 – February 2020

AGRICULTURE & FOOD

e - Newsletter

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

OSMOTIC DEHYDRATION: A gentle pre-treatment

Article id: 22890

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INTRODUCTION

About 20–40 percent of the fruit and vegetable production in India goes waste due to lack of proper retailing and adequate storage capacity. The production of vegetables in India is next only to China. The vegetable and fruit production contribute more than 30% of the agriculture GDP (Gross Domestic Product). The crop diversification has led to a rise in horticulture production, which has reached 185.2 billion tonnes in 2010. But the real challenge starts after the production.

Preserving food to extend its shelf-life, with ensuring its safety and quality, is a central preoccupation of the food industry. As a result, there has been a steady stream of new 'minimal' preservation techniques. At the same time, the development of the hurdle concept has led to renewed interest in the use of more traditional preservation methods and the ways they can be combined with newer technologies.

Food preservation is the process of treating and handling food to stop or greatly slow down spoilage (loss of quality, edibility or nutritive value) caused or accelerated by micro-organism. Preservation usually involves preventing the growth of a bacterium, fungus, and other microorganisms as well as retarding the oxidation of fat which causes rancidity. It also includes processes to inhibit natural aging and discoloration that can occur during food preparation such as the enzymatic browning reaction in apples after they are cut.

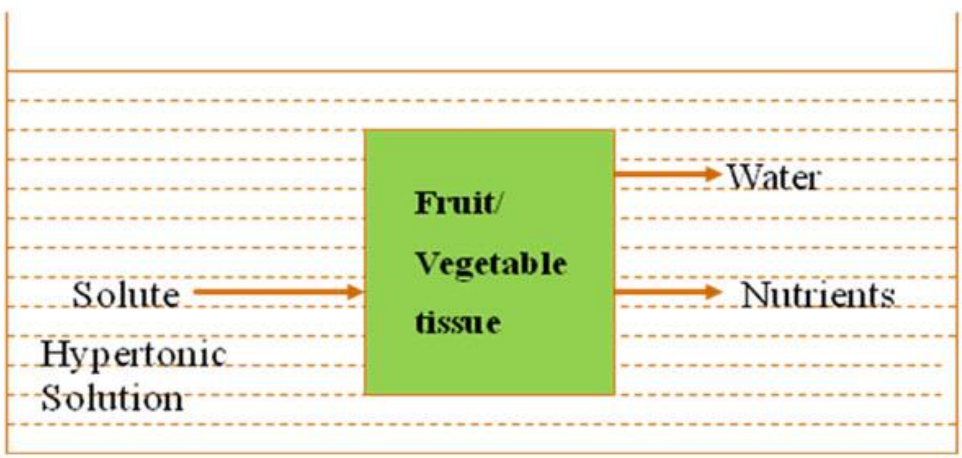
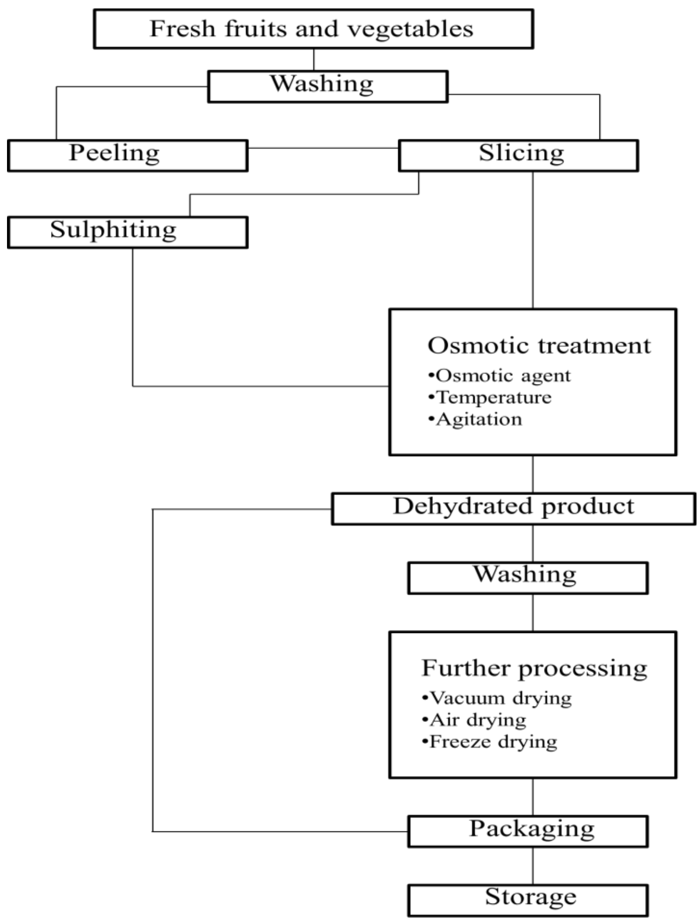


Fig: Osmotic dehydration process

Osmotic dehydration is the phenomenon of removal of water from a lower concentration of solute to higher concentration through semi- permeable membrane results in the equilibrium condition in both sides of the membrane (Tiwari, 2005). There are lots of positive benefits of osmotic dehydration including the longer shelf life of fruits and vegetables, maintaining nutritional aspects and flavors of fruits and vegetables, preventing the occurrence of microbial spoilage and easy transport and handling of fruits and vegetables. Also, it has potential advantages of less heat damage, good blanching effect, less enzymatic browning, better retention of flavor, color, texture and energy saving because no phase change occurs. Moreover, for fruits and vegetables, the osmotic pre-treatment prior to other drying methods improves the quality of its nutritional, sensorial and functional properties (Alam *et al*., 2010).

In osmotic dehydration, the solutes used are generally sugar syrup with fruit slices or cubes and salt (sodium chloride) or brine with vegetables. This is multi-component diffusion process. In this process water flow from fruits or vegetables to solution and along with water some components of fruits and vegetables such as minerals, vitamins, fruit acids etc. also move towards solution. The sugar and salt migrate towards the fruits and vegetables. The process of complete osmotic dehydration has been shown by the flow diagram.



The most important products of commercial importance available in the market made from fruits are murabbas of gooseberry (Aonla), apple, candies of different fruits and vegetables like pethas, sweets of parwal made by osmosis in sugar syrup. In pickles making from raw mango, it is treated in a brine solution before drying. Various vegetables are treated in brine to reduce their moisture content.

The advantages of osmotic dehydration are as follows:

a. It is a low temperature water removal process and hence minimum loss of color and flavor takes place.
b. Flavor retention is more when sugar or sugar syrup is used as an osmotic agent.
c. Enzymatic and oxidative browning is prevented as the fruit pieces are surrounded by sugar, thus making it possible to retain good color with little or no use of sulfur dioxide.
d. Removal of acid and uptake of sugar by the fruit pieces give a sweeter product than a conventionally dried product.
e. It partially removes water and thus reduces water removal load at the dryer.
f. Energy consumption is much less as no phase change is involved.
g. It increases solid density due to solid uptake and helps in getting a better quality product in freeze drying.
h. If salt is used as osmotic agent, the higher moisture content is allowed at the end of drying as salt uptake influences the water sorption behavior of the product.
i. The textural quality of the product is better after reconstitution.
j. The storage life of the product is greatly enhanced.

It has some disadvantages and inconveniences too, and they are given below:

a. The reduction in acidity level reduces the characteristic taste of some products. This can overcome by adding fruit acid in the solution.
b. Sugarcoating is not desirable in some products and quick rinsing in water may be necessary after the treatment.
c. Osmotic dehydration with other combined processes such as vacuum drying, air drying or blanching was found expensive.
d. In osmotically dehydrated products, water activity is found higher.
e. It is a time taking process.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Push-pull strategy: a new concept for eco friendly pest management

Article id: 22891

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1. INTRODUCTION

The term push-pull was first conceived as a strategy for insect pest management (IPM) by Pyke *et al.* in Australia in 1987. They investigated the use of repellent and attractive stimuli, deployed in tandem, to manipulate the distribution of *Helicoverpa* spp. in cotton, thereby reducing reliance on insecticides, to which the moths were becoming resistant. The concept was later formalized and refined by Miller & Cowles, who termed the strategy stimulo-deterrent diversion while developing alternatives to insecticides for control of the onion maggot (*Delia antiqua*). In this review, we retain the original terminology. We describe the principles and components of the push-pull strategy, summarize developments over the past 20 years since the term was coined, and discuss how the strategy may contribute to addressing the global demand for the reduction of toxic materials in the environment as part of IPM strategies in the future.

What is push?

The pests are repelled or deterred away from resources by using stimuli that mask host apparency or are repellents or deterrents.

What is Pull?

The pests are simultaneously attracted by using highly apparent and attractive stimuli to other areas such as traps or trap crops.

The principles of the push-pull strategy

- To maximize the control efficacy, efficiency, sustainability and output.
- To minimizing negative environmental effects.

2. PUSH-PULL COMPONENTS

<u>Push components</u>

Synthetic repellents

Repellents such as MNDA (*N*-methylneodecanamide) and DEET (*N,N*-diethyl-3-methylbenzamide, often referred to as *N,N*, diethyl-*m*-toluamide) are commercially available and may be used in push-pull strategies against cockroaches and invasive lady beetles. DEET is considered the most effective commercial repellent available and is used primarily to repel hematophagous insects. However, there are concerns over its safety and alternatives are sought.

Shah *et al.,* (2008) observed that the highest mean repellency rate of *Oryzaephilus surinamensis* by using water extract of *Pongamia pinnata* (41.67 %) and the lowest in acetone extract of *Typhonium trilobatum* (21.11 %) on wheat grain.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Antifeedant

According to Halder *et al.,* (2009) reduction of feeding by *Helicoverpa armigera* was maximum (70.3 %) at 5000 ppm dose of methanolic extract of *vincarosea* on cabbage leaves. Dolui and Debnath (2010) reported that the number of feeding spot of tea mosquito bug after treatment with 4 per cent methanol extract of *Heliotropiumindicum*on leaf (18.67 per plant) and on flower (22.33 per plant) was lower.

Non host volatiles

Volatiles derived from non-hosts can be used to mask host odors or evoke non-host avoidance and repellent behaviours. Plant essential oils such as citronella and eucalyptus are commercially produced as repellents against hematophagous insects .

Host derived semiochemicals

Insects recognize suitable hosts by using key volatiles that are often present in specific ratios. Directed host orientation ceases if host odors are presented in inappropriate ratios, as demonstrated for the Colorado potato beetle (*Leptinotarsa decemlineata*). Repellent behaviors may be elicited if the host odors signal poor-quality hosts. For example, the codling moth (*Cydia pomonella*) was repelled by the odors of apple at inappropriate phenological stages. Also, herbivore-induced plant volatiles (HIPVs) can deter plant utilization by subsequent herbivores as indicators of competition or induced defenses. HIPVs are produced by the plant as indirect defenses that attract natural enemies of the herbivore (see pull section), in addition to an increase in direct physical and chemical defenses that affect herbivore performance. For example, methyl salicylate and (*Z*)- jasmone are HIPVs repellent to aphids when released in the field .

Pull components

Visual stimulants

Visual stimuli are rarely the sole method used to attract pests to traps or trap crops, but they can enhance the effectiveness of olfactory stimuli. Blue and black traps, approximating the size of a mammalian host, are used to control cattle tsetse fly (*Glossina* spp.). Crucial to the development of efficient traps was the finding that black stimulates landing. In plant-based strategies, the visual cues related to the plant growth.

Ashfaq *et al.,* (2005) observed that highest number of insect has been attracted at black light (42.10 %). They also reported blue light was more attractive to Ephemeropteran, Orthopteran and Dermapteran insect, while black light more attractive to Lepidopteran, Dipteran, Coleopteran, Hemipteran and Plecopteran insect.

Sex and aggregation pheromones

Insects release sex and aggregation pheromones to attract conspecifics for mating and optimizing resource use. Both types of pheromones are increasingly important components of IPM, particularly in pest monitoring. Traps baited with these pheromones have a lower detection threshold than other methods and can help in push-pull strategies to determine the timing of stimuli deployment and population-reducing interventions. Male-produced pheromones that attract females over a long range are most useful in direct control strategies. Male-produced sex pheromones from the sandfly (*Lutzomyia longipalpis*) have been identified and synthetically produced and may be used for the control of leishmaniasis. Aggregation pheromones represent the primary pull stimulus used in push-pull strategies for forest pests.

Host plant odor can enhance or synergize the attraction of herbivores to sex and aggregation pheromones. Patel *et al.,* (2009) noted highest mean number of moth of *Helicoverpa armigera*in 24 traps/acre (3638 moths/acre) in chick pea fields. Singh *et al.,* (2011) reported highest fruit flies traped in 25 trees/trap treatment and also noted highest yield 164.28 kg/tree and lowest per cent fruit infestation (1.06 %) in mango.

3. How Push-Pull Works

The Push-Pull technology involves use of behavior-modifying stimuli to manipulate the distribution and abundance of stem borers and beneficial insects for management of stem borer pests (Figure 1). It is based on in-depth understanding of chemical ecology, agro biodiversity, plant-plant and insect-plant interactions, and involves intercropping a cereal crop with a repellent intercrop such as desmodium (push), with an attractive trap plant such as Napier grass (pull) planted as a border crop around this intercrop. The stem borer females are repelled from the main crop and are simultaneously attracted to the trap crop. Napier grass produces significantly higher levels of attractive volatile compounds (green leaf volatiles), cues used by gravid stem borer females to locate host plants, than maize or sorghum. There is also an increase of approximately 100-fold in the total amounts of these compounds produced in the first hour of nightfall by Napier grass (scoto phase), the period at which stem borer moths seek host plants for oviposition, causing the differential oviposition preference. However, many of the stem borer larvae, about 80%, do not survive as Napier grass tissues produce sticky sap in response to feeding by the larvae which traps them causing their mortality. Legumes in the Desmodium genus (silver leaf, *D. uncinatum* and green leaf, *D. intortum*), on the other hand produce repellent volatile chemicals that push away the stem borer moths. These include (E)-ß-ocimene and *(E)-4,8-dimethyl-1,3,7-nonatriene*, semiochemicals produced during damage to plants by herbivorous insects and are responsible for the repellence of desmodium to stem borers.

Desmodium also controls striga, resulting in significant yield increases of about 2 t/ha per cropping season. In the elucidation of the mechanisms of striga suppression by *D. uncinatum*, it was found that, in addition to benefits derived from increased availability of nitrogen and soil shading, an allelopathic effect of the root exudates of the legume, produced independently of the presence of striga, is responsible for this dramatic reduction in an intercrop with maize. Presence of blends of secondary metabolites with Striga seed germination stimulatory, *4′′,5′′,-dihydro-5,2′,4′-trihydroxy-5′′,-isopropenylfurano-(2′′,3′′;7,6)-isoflavanone, and post-germination inhibitory, 4′′,5′′-dihydro-2′-methoxy-5,4′-dihydroxy-5′′-isopropenylfurano- (2′′,3′′;7,6)*-isoflavanone, activities in the root exudates of *D. uncinatum* which directly interferes with parasitism was observed. This combination thus provides a novel means of in *situ* reduction of the striga seed bank in the soil through efficient suicidal germination even in the presence of graminaceous host plants in the proximity. Other *Desmodium* spp. have also been evaluated and have similar effects on stem borers and striga weed and are currently being used as intercrops in maize, sorghum and millets.

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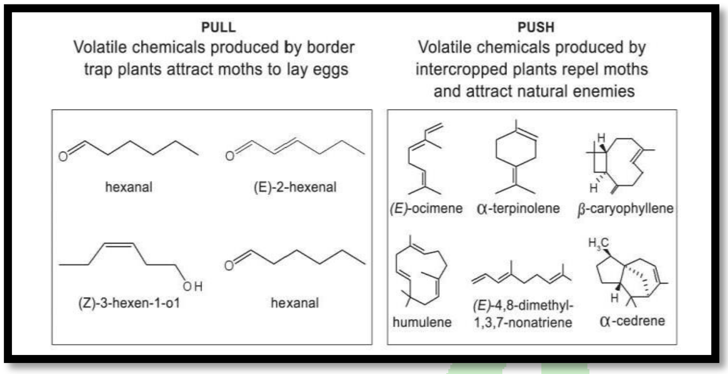
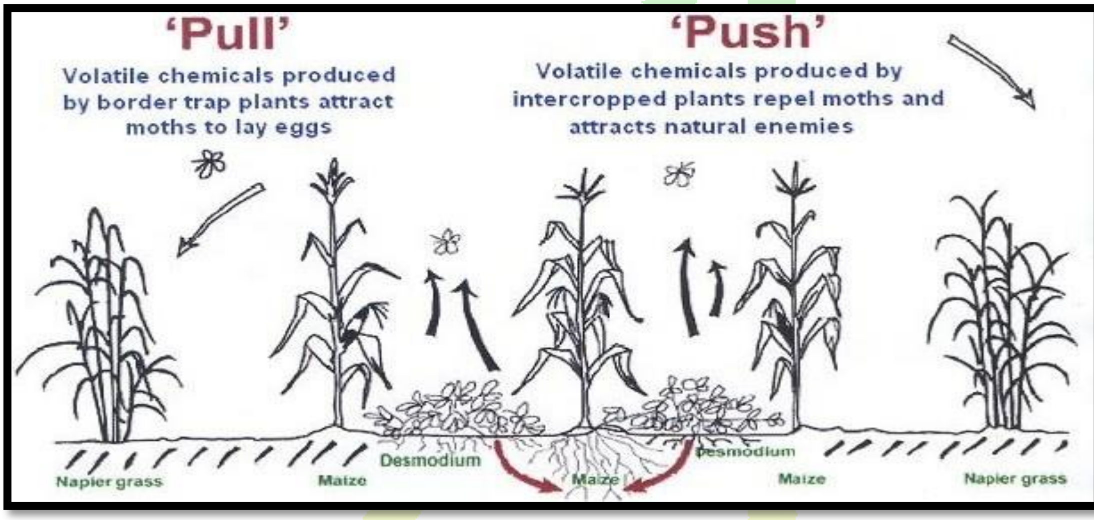
e-ISSN: 2581 - 8317
Volume 2 – Issue 2 – February 2020





Push-Pull Strategies in Intensive Agriculture

Development of push-pull strategies has been directed mainly at pest problems in intensive agricultural systems, yet owing to the continued reliance on cheap insecticides, at present none are used commercially. However, push-pull strategies are beginning to be seriously considered as plausible pest control solutions that help to manage insecticide resistance threats or negate altogether the need for insecticides.

Control of *Helicoverpa* in cotton

Helicoverpa species are polyphagous lepidopterous pests of a wide range of crops. The potential of combining the application of neem seed extracts to the main crop (push) with an attractive trap crop, either pigeon pea (*Cajanus cajan*) or maize (*Z. mays*) ('pull') to protect cotton (*Gossypium hirsutum*) crops. Trap crop efficiency was increased by application of a sugar-insecticide mix. Trap crops, particularly pigeon pea, reduced the number of eggs on cotton plants in target areas and remained effective throughout the trial, although the degree of efficacy varied with growth stage. In trials, the push-pull strategy was significantly more effective than the individual components alone and reduced the number of eggs three days after application of the bait by 92%, 40%, and 78%, respectively, against the untreated control when pigeon pea was at its most attractive stage.

Control of *Sitona lineatus* in beans

Sitona lineatus, the pea leaf weevil, is a pest of field legumes. Adult feeding reduces leaf area, while larvae damage the nitrogen-fixing root nodules. Commercially available neem antifeedant (push) and synthetic aggregation pheromone 4-methyl-3,5-heptanedione released from polythene dispensers (pull) were tested as components of a push-pull strategy for *S. lineatus* in field trials using fava beans (*Vicia faba*). Both components altered the abundance and distribution of weevils as predicted. The neem antifeedant was as effective as the insecticide control treatment in reducing the abundance of weevils, but repeated applications were necessary to maintain efficacy. The crop perimeter treated with the aggregation pheromone could be used as a semiochemically assisted trap crop.

Control of the pollen beetle in oilseed

A push-pull strategy based on an attractive trap crop is being developed to protect oilseed rape (*Brassica napus*) from its specialist pests. Turnip rape (*Brassica rapa*) is a preferred host for several oilseed rape pests . Simulations using a spatially explicit individual based model indicated that a perimeter trap crop was the most appropriate arrangement. In field trials, a perimeter turnip rape trap crop significantly reduced the abundance of the pollen beetle (*Meligethes aeneus*) in spring-sown plots of oilseed rape compared with plots without a trap crop.

4. Advantages and Disadvantages of Push-pull strategies

Increased efficiency of individual push and pull components

Individual elements may fail because their effects are not strong enough to effect control on their own. For example, trapping strategies using attractive baits may have a significant impact on species with low reproductive rates but fail for species with high reproductive rates. By adding another component with negative effects on host selection, the preference differential is increased and the additive effects may reduce pests to below economic thresholds.

Improved potential for use of antifeedants and oviposition deterrents

The use of these tactics in IPM is often limited or ineffective because of habituation, or host deprivation, in the absence of more suitable hosts. By adding pull stimuli, a choice situation is created and alternative feeding or ovipositional outlets are provided, which can mitigate these effects.

Increased efficiency of population reducing components

As the pest populations are concentrated in predetermined areas (either traps or trap crops), less chemical or biological control material is required to treat the pest population, thereby reducing costs. Leaving areas untreated also provides an enhanced opportunity for the conservation of natural enemies and other non target organisms.

Resistance management

Behaviour-modifying stimuli used in push-pull strategies are used in combination and are not highly effective when used alone, the components do not select strongly for resistance. The strategy is generally compatible with the use of conventional insecticides, and the reduction in the amounts required for control reduces the opportunity for pests to develop insecticide resistance.

Disadvantages

Limitations to development

A good understanding of the behavioural and chemical ecology of the host-pest interactions and the effects of the strategies on beneficial is essential but requires considerable research effort. If knowledge is insufficient, control may break down and robustness and reliability are reduced. Development of semio chemical components is often limited by formulation and delivery technology.

Registration

Owing to a small and specialized market, the cost of semio chemical registration is often high.

Limitations to adoption

An integrated approach to pest control is more complex, requiring monitoring and decision systems, and currently incurs higher operational costs than does the sole use of insecticides. The comparatively variable efficacy that comes with incomplete knowledge of the biological operation of the whole strategy, has limited uptake.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Scientific goat farming in India : A beginner's guide

Article id: 22892

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INTRODUCTION :

Goat is known as 'Poor man's cow' in India and is a very important component in dry land farming system. Goat is a multi-functional animal and plays a significant role in the economy and nutrition of landless, small and marginal farmers in the country.Goat farming is an enterprise which has been practiced by a large section of population in rural areas. Goat can efficiently survive on shrubs and tree in adverse harsh environment in low fertility land where no other crop can be grown. In pastoral and agricultural subsistence societies in india, goats are kept as a source of additional income and as an insurance against disaster. Goat meat is also being used in ceremonial feastings.

Benefits of Goat Farming :

There are some benefits of goat farming. If you want to start goat farming then you must read the benefits of raising goats.

- Goats are multi purpose animal which can produce milk, meat, fiber, skin together.
- Goats are prolific breeders and achieve sexual maturity at the age of 10-12 months gestation period in goats is short and at the age of 16-17 months it starts giving milk. Twinning is very common and triplets and quadruplets are rare.
- Compared to cow and other livestock farming, goat farming requires less space and additional facilities. They have a less demand of housing and other management. In small scale production they are also able to share their homes with their owners and his/her other livestock.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

- Production costs like infrastructure, feeding and treatment are less.
- You don't have to think about marketing your farm products. Because there are already an established market in the country for marketing your products.
- It is really very easy to maintain a goat farm compared to other farm animals.
- Goats can adopt themselves with almost all types of agro-climatic conditions. And diseases are less in goats.
- They are smaller in size but reach slaughter age faster.
- Goat products like meat and milk has no religious taboo. And highly accepted for consumption throughout the world.

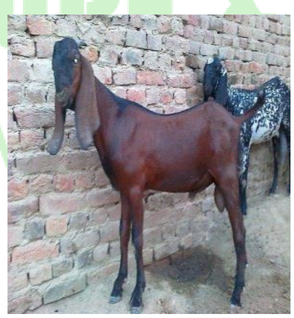
Some Important Breeds :

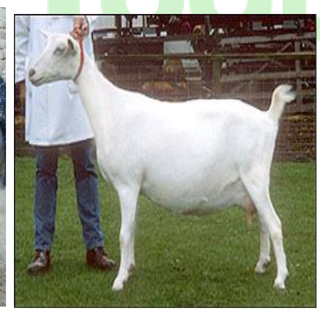
There are numerous goat breeds available in India. But all goats are not suitable for commercial production. Some goat breeds are highly productive and very suitable for commercial farming in India.

- **Jamunapari Goat:** Jamunapari goat is a native goat breed of India. It is a highly milk and meat productive goat. But they are raised mainly for their highly milk production capacity. A female goat can produce about 2-3 litter milk daily. An adult male weights about 65-90 kg and female goat weights about 40-60 kg.
- **Boer Goat:** Boer goat is a South African goat breed but suitable for farming in India. They are meat productive goat breed. And adult Boer goat weights about 110-115 kg and a female goat weights about 90-100 kg.
- **Black Bengal Goat:** Black Bengal goat is a Bangladeshi goat breed. This goat breed is considered as an important small livestock in Bangladesh. They are very suitable for meat, milk, skin and fiber production. This goat breed can adopt themselves with almost all types of climate easily. Their meat and milk are very tasty and has a great demand.
- **Beetal Goat:** Beetal goat is a native Indian goat breed. They are highly milk productive goat breed. Also suitable for highly meat production. They are able to produce about 2.5-4 litter milk daily. An adult male goat weights about 65 kg and female about 45 kg.
- **Saanen Goat:** Saanen goat is a dairy goat breed of Switzerland. But suitable for commercial milk production in India. They can produce milk highly like Jamunapari and Alpine goat. They are able to produce about 3.8 litters milk daily. An adult male Saanen goat weights around 70-90 kg and female around 60-70 kg.


Jamunapari


Black Bengal


Beetal


Saanen

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Housing management :

Goat shed requires adequate sun light, well ventilation for free flow of fresh air and dry floor particularly in the region where rainfall and humidity is very high. The height of the floor of the house should have at least 3-3.5 fts from the ground so that cleanliness of both inside and outside area could be done easily. An adult goat requires 2.5ft × 4.5ft of space. Bamboo slats or wooden slats 3" thick and 1" wide (7.5 cm and 2.5 cm respectively) may be used as flooring material which are laid one after another leaving about 1" gap in between. The wall of the shed should have the provision of good ventilation.

Feeding management :

Goat eats almost all types of grasses and tree leaves. It does not require any extra feed after grazing. But, if provides some amount of concentrated feed (150-200g) to them then that improves its body weight as well as general health of the animals. Pregnant and milch animals should be provided feed supplemented with more protein and energy. The ingredients of concentrated feed for goat as given below.

Ingredients	Percent (%)
Maize	50
Rice polish	25
GNC	12
Skimmed milk powder	11
Min. mixture	2
Salt	1

Kitchen waste may be utilized as goat feed that can be reduced the requirement of concentrated feed.

Health management :

- Provide clean and uncontaminated feed and water for minimizing the health disorders.
- Strictly follow the recommended vaccine.
- Deworm the animal regularly.
- Examine the faces of adult animals to detect eggs parasites and treat the animals with suitable drugs.
- Consult the nearest veterinary aid center for help if illness is suspected.

Vaccination schedule for goats

Months	Vaccine	Adult goat	Kids(above 6 months)
January	Contagious pleuro pneumonia	0.2ml/dermal	0.2ml/dermal
March	Hemorrhagic Septicemia	5ml S/c	2.5ml S/c
April	Goat Pox	Scratch method	Scratch method
May	F.M.D.	5ml S/c	5ml S/c
June	Rinderpest	1ml S/c	1ml S/c
July	Black Quarter	5ml S/c	2.5ml S/c
August	F.M.D	5ml S/c	0.5ml S/c
September	Enterotoxaemia	5ml S/c	2.5ml S/c

Breeding care :

- It should be planned to obtain 3 kidding in 2 years period by adopting optimal management condition.
- For every 25 does one buck should be provided in one breeding season.
- Breed the animals 12 hours after the onset of the first symptoms of heat for maximum conception.
- Anestrous animal must be examined thoroughly as directed by veterinary doctor for prompt elimination of causes for anoestrus or cull them if necessary.

Marketing :

The marketable products of goat farming includes the fattened kids, manure, culled animals. Marketing avenues for the above products are slaughter houses and individual meat consuming customers and agriculture farms. Therefore availability of either slaughtering facilities or traders who will purchase live animals should be ensured to convert the fatteners into wholesome meat and meat products. Further, demand for manure from nearby agriculture farms must also be ensured.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Tomato Leaf Curl New Delhi Virus in Cucurbitaceous Vegetables: an Emerging Threat in Global Cucurbit Production

Article id: 22893

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INTRODUCTION:

Tomato Leaf Curl New Delhi Virus (ToLCNDV) is a bipartite begomovirus belonging to the family Geminiviridae. The genome of this virus consists of two circular single-stranded DNA molecules of about 2.5 to 2.7 kb size, often referred to as DNA-A and DNA-B. The DNA remain encapsidated within twin-shaped ('geminate') virions. This virus is transmitted by the viruliferous whiteflies (*Bemisia tabaci*). Although, ToLCNDV, a new strain of *Tomato Leaf Curl Virus* (ToLCV), was first reported to infect tomato in New Delhi during 1995, within no time, it started infecting other Solanaceous crops. Now the virus has been reported to infect almost all members of family Solanaceae and Cucurbitaceae.

Distribution:

Soon after its prevalence in India, several articles were published from other Asian countries about its occurrence in wide range of vegetable crops. Outside India, the virus was first reported from Murcia, Spain where it caused typical symptom on courgette (*Cucurbita pepo* var. *giromontiina*) during September 2012. Later in 2013, the virus was widespread in the entire Spain. The virus was detected for the first time in Tunisia during September 2015. In Tunisia, the virus was reported to cause a severe crop loss of melon, cucumber and courgette (a type of summer squash). Keeping in view the wide host range and its extent of damage in the Euro-Mediterranean region; this emerging virus has been added in the alert list of European and Mediterranean Plant Protection Organization (EPPO). In India, other than New Delhi, a widespread occurance of the virus has been reported from Andhra Pradesh, Gujarat, Punjab, Haryana, Uttar Pradesh, Maharashtra, Karnataka and West Bengal. This devastating virus has been also reported from countries like Bangladesh, Indonesia, Sri Lanka, Phillipines, Taiwan, Thailand and Pakistan.

Host Range:

The virus was first reported to infect tomato in New Delhi (so is the name) followed by all the remaining solanaceous vegetables *viz.*, brinjal, chilli, capsicum and potato and later it started infecting almost all the cucurbits *viz.,* watermelon, muskmelon, cucumber, ridge gourd, bottle gourd, bitter gourd, wax gourd, courgette, pumpkin and squashes. Other than these vegetable crops, the virus has also been found in weed i.e. *Eclipta prostrate* (Asteraceae); in other crops like *Hibiscus cannabinus* (Gongura-Malvaceae) and in *Carica papaya* (Papaya-Caricaceae) (Raj *et al*. 2008).

Symptoms and Damage:

On Foliage: Symptoms on foliage include leaf puckering, distortion of the leaf lamina which is also associated with upward curling, vein clearing, vein swelling and development yellow mosaic pattern. The infected plants remains stunted and the yield loss may go up to 100 per cent if the plants get infected in early growth stages (Chakraborty, 2008).

On Fruits: Symptoms on fruits are mainly observed in gourds and melons. Upon infection, the fruit skin becomes rough due to formation of corky layers followed by longitudinal cracking of the fruits, leading to a huge crop loss.

Curling of cucumber leaves

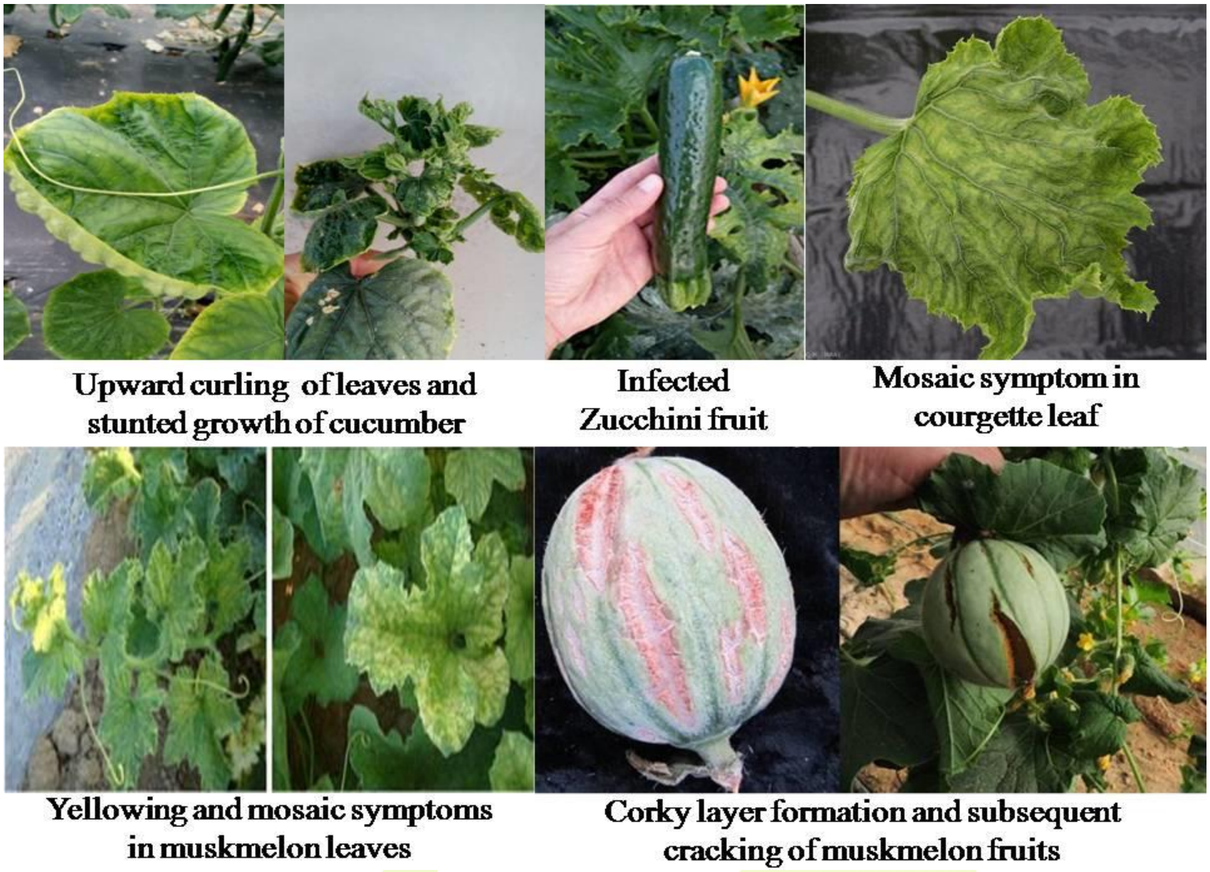
Curling of squash leaves

Mosaic symptom of squash leaves

Cupping of squash leaves

Epdimiology:

The disease is found to be very severe in the crops grown during the summer and rainy seasons. The moderate to high temperature and humidity during this period favours the population buildup of the whitefly vectors.



Symptoms of ToLCNDV in different cucurbits

Management strategies:

Although the virus has wide host range and causes huge crop loss in most of the economically important vegetable crops, very limited management measures are available which mainly rely on i) management of whitefly and ii) avoidance of the vector by cultivating inside insect proof 40-mesh net-houses. The vector can be managed through one or more of the following ways:

- **Physical removal** of the leaves and plants which are heavily infested with non-mobile nymph and pupae helps to bring down the population. Complete destruction of crop debris after harvest and maintainance of good phytosanitation will help to destroy the eggs as well as the hibernating population.
- **Border cropping** with any tall growing cereals *viz*., jowar or maize all around the main field will distract the whiteflies from coming to the main crop.
- **Use of reflective mulch** on the ridges will keep away the whiteflies and other sucking pests from the vicinity of the plants.
- **Use of yellow sticky trap** @ 10 traps per hectare will attract the whiteflies towards it and divert them from the crop plants.
- **Biological control** by using natural predators *viz.,* lacewings, big-eyed bugs and pirate bugs can also be followed. Several small lady bird beetles including *Clitostethus arcuatus* and

scale predators, such as *Scymnus* or *Chilocorus* species and the Asian multicolored lady beetle, *Harmonia axyridis* feed on whiteflies. Although this method is quite good for protected conditions, they are not generally recommended for open field.

- **Foliar spray of botanicals** like Neem Seed Karnel Extract (NSKE) @ 5% or other materials like fish oil along with resin soap @ 1.4-1.5 Kg per hectare can be used to manage whitefly, especially in organic crops.
- **Chemical management with systemic insecticides** *viz.*, imidacloprid @ 0.5 ml/l or acetamiprid or diafenthiuron @ 1g/l alternatively at weekly interval.

Summary and Conclusion:

The virus has a small genome and therefore is very prone to mutation, which give rise to new virulent strains. Mixed infection of several viruses in a particular susceptible plant also gives rise to more virulent recombinant strains. Fortes *et al.* (2016) characterized one such strain of ToLCNDV in Spain. Moreover, the presence or absence of the beta satellite region in the genome also affects the pathogenicity of the virus. Therefore, to avoid the chances of development of new strains, it is better to avoid a variety, which shows susceptibility to more than one virus, including ToLCNDV. Development of resistant varieties is the most economical and is also an environmentally sound method but till date, no commercial varieties are available in any of the vegetable crops in India. In this regard, breeding works have been initiated in different ICAR institutes. Until and unless the resistant varieties are released, the integrated management of whitefly remains the best option to manage this disease.

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MARINE ECOSYSTEM: AN OVERVIEW

Article id: 22894

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Marine ecosystems are the largest of earth's aquatic ecosystem and are distinguished by waters that have a high salt content. These systems contrast with fresh water ecosystem, which have a lower salt content. Marine ecosystem covers the largest surface of the Earth. It has 97% of Earth's water. It is composed of coral reefs, salt marshes, rocky shores, estuaries, sandy shores & oceans. It provides food & shelter to large no. of organisms. It has high biodiversity & high productivity. The key processes of marine ecosystems are to capture solar energy and transfer that energy among various groups of animals and plants. This energy production then supports virtually all life in the oceans and on land as well. Understanding these connections is essential to valuing the full range of goods and services supplied by marine ecosystems. Although marine ecosystem science (incorporating the physical sciences, biology, and social sciences) is still relatively young, significant progress has been made in theory, observation, and experimentation.

INTRODUCTION

Marine ecosystems are among the largest of Earth's aquatic ecosystems. It covers approximately 71% of the Earth's surface & contains approx. 97% of the planet's water. It generates 32% of the world's net primary production. Approximately 85% of the dissolved materials in sea water are Sodium & Chlorine with salinity of 35% ppt. Marine ecosystems such as coral reefs provide food & shelter to the highest levels of marine diversity. They usually have a large biodiversity & have a good resistance against invasive species. Coastal habitats alone account for approximately 1/3 of all marine biological productivity & estuarine ecosystems are among the most productive regions on the planet (World resource centre). Marine ecosystems can be defined on many spatial scales, ranging from the entire marine environment of the earth to a small bay or estuary. The defining characteristics of an ecosystem apply no matter how the ecosystem of interest is defined. Marine ecosystems are defined by their geography, the animals and plants within that geographical scope (including humans), as well as aspects of the physical, chemical, and biological environment and the processes that control ecosystem dynamics. The environment of the ecosystem includes the biological, chemical, physical, and social conditions that influence organisms, and the environment is usually described in terms of the aspects (physical, chemical, and biological) important to a process under discussion. Many of the important physical and biological processes in the marine environment (such as sea surface temperature, illustrated in the top panel above, as monitored by satellite), show gradual changes over large spatial scales. Likewise, while some animals and plants live their entire lives in a much localized area (few square kilometers) others, such as the great whales and migratory fishes such as tunas, use entire ocean basins. One useful concept is to look at the world's oceans at an intermediate scale known as Large Marine Ecosystems, or LMEs. Several studies have defined about 45 LMEs in the world's oceans, with eight of these occurring in U.S. territorial seas and the Exclusive Economic Zone (EEZ). At the scale of LMEs, we can link variations in the physical and chemical environment with biological productivity, the status of various marine populations, and the wide spectrum of human interactions contributing to observed changes. The LMEs in the United States will increasingly be the focus of regional ecosystem science and management activities. It must be recognized, however, that these boundaries will remain somewhat subjective, and for some issues, other narrower or wider boundaries will be necessary. The marine food chain, or "web," has at its base the production by marine plants of phytoplankton. At successive tropic levels (1 = phytoplankton, 2 = zooplankton, etc.), the amount of mass that can be supported is only about 10 percent of the mass at the lower adjacent level. This is because considerable amounts of energy are required for growth, movement, and reproduction. Nutrients released by these processes are recycled by the ecosystem back to the base of the food chain. Human activities influencing the marine food web include increasing nutrients in the coastal systems, which may stimulate phytoplankton production (which may have a variety of consequences for ecosystems). Harvesting at the top levels of the pyramid may also alter the number of animals in lower levels, resulting in changes in the availability of species for human uses, as well as in the dynamics of the ecosystem. Ecosystems are influenced not only by variations in the world and regional climate, but by a variety of human activities as well. Most importantly, these human activities include nutrient enrichment of coastal areas (such as Chesapeake Bay), modifications of the coastal zone (dredging, pier construction, mining, and fishing impacts on bottom habitats), as well as direct harvesting effects for some animals. Activities such as harvesting influence both the abundance of important species, such as Atlantic cod, and their geographic distributions. For example, the collapse of cod stocks off Newfoundland resulted in the shrinking of their distribution, as well as changes in the abundance of some of their prey species. In particular, marine invertebrate species such as shrimp and crabs are now more abundant than before the cod-a predator of these species-declined. Observing systems for marine ecosystems thus need to monitor the spatial distribution of important animal populations as well as the factors controlling their abundance.

Important Categories of Marine Ecosystems

1. Rocky Intertidal

This marine community has extreme biodiversity. It is one of the Earth's most densely populated areas. Organisms must be adapted to wave action, changing tide levels. This marine community has extreme biodiversity. It is one of the Earth's most densely populated areas. The ocean meets the land in this community and it has a large number of habitats and niches.

2. Sandy and Cobble Beaches

This marine community is where the ocean meets the land. It is a very harsh environment. There are some species who have adapted well to this environment. It experiences the extremes of the ebb and flow of the tides. Not as much biodiversity as rocky shores, not much habitat diversity and sand dries out at low tide. Some small things can live in the sand, food for shorebirds

3. Salt Marshes

A low area that is subject to regular, but gentle, tides dominated by grass. Marshes do not have trees or shrubs.

4. Estuaries

An area in which fresh water from a river mixes with salt water from the ocean; a transition area from the land to the ocean. Other names: bay, sound, lagoon and harbor.

Characteristics of Estuaries

Water is brackish: A mixture of freshwater and saltwater. There is a gradient (gradual change) in the salinity

- Near the input from the river: 0-5 ppt
- In the middle of the estuary: 5-25ppt
- At the ocean: >25 ppt (ppt = parts per thousand, a unit for salinity)
- Very nutrient rich ecosystems → leads to high productivity and high biodiversity
- Fast-moving rivers and waves carry nutrient-rich particles
- Sediment settles out in the estuary when the water slows down
- It accumulates on the bottom (benthic zone)
- Great place for plants to grow.

Important Functions of Estuaries for Living Things

- Habitat
- Nursery
- Fisheries
- Recreation
- Water purification and Flood control
- Estuary plants: Cordgrass, Narrow leaved cattail, glasswort.
- Estuary animals: Horseshoe crabs, Oysters, Lobster, flounder, striped bass and Sea lion
- Estuary birds: Great White Egret, common tern.

5. Mangrove Swamps

Coastal wetlands located in tropical and subtropical zones; characterized by salt-tolerant trees and shrubs, such as mangrove trees. Different species include red mangrove with tangled roots that reach above the water line, form an important habitat for many animals.

6. Coral Reefs

Structures in the shallow oceans that are built by animals called corals; serve a habitat for many diverse organisms. It requires two things: warm temperatures and sunlight. It founds between 30°N and 30°S of the equator. Corals are animals that belong to the phylum Cnidaria, the stinging-celled animals such as jellyfish and hydra. Coral polyps resemble small sea anemones with tentacles that can sting and paralyze prey. They build limestone houses around themselves and stay in one spot (sessile). Over many generations, the limestone builds up to form a large reef (takes a long time). Corals live in a symbiotic relationship with algae called zooxanthellae the algae are photosynthetic and give the coral food and oxygen; the algae get carbon dioxide and nutrients from the nitrogenous wastes of the coral. There are many different kinds of corals: Soft & hard corals. Growing on the reef with the corals are other animals, such as sponges, worms, shrimps, crabs, mollusks. Living in and around the reef are fish, sea turtles, sea snakes, marine mammals.

Coral Reef Destruction

- Coral Bleaching: When temperatures go above normal, the zooxanthellae (algae) in the coral can be rejected; the coral turns a whitish color and dies.
- Natural Causes: El Nino
- Manmade Causes: Global warming, physical damage, ships, anchors, tourist divers
- Dynamite Fishing: Reefs are damaged by physical destruction that may occur when people collect fish.
- Land Development and Pollution: loss of mangrove forests means more nutrients and sediments flow out to the sea; coral may die from sediment or algal blooms. Fish and coral trade and increased exposure to UV due to ozone depletion.

Hydrothermal Vents

This marine community has super-heated water. It contains white and black smokers. Bacteria are the primary producers and make food through chemosynthesis. Deep sea fish are at the top of the food chain in this environment. This environment could have been the starting point for life on Earth.

Kelp Forests

This marine community is found along coastlines, in cool waters. El Nino can have devastating effects on this environment. It contains large communities of brown algae. The keystone species are the algae, purple sea urchins, and sea otters.

Ocean: Open and Deep

Varying surface of ocean floor: continental shelf, slope, trenches (deepest is Mariana Trench at about 35,000 feet below sea level), plains, geologic features (hydrothermal vents, volcanoes, fault lines that produce earthquakes and tsunamis).

- Open Ocean: It is called Pelagic Zone. This community contains 83% of the ocean's total biomass in the uppermost 200 meters. Below that few species live.
- Deep Ocean: It is called Benthic Zone. This marine community is very cold. It has a high level of salinity, density, and pressure. Some organisms thrive in this environment especially the brittle star.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Characteristics: Dark, Cold, High Pressure

- Marine snow: organic particles that settle down from above.
- Hydrothermal vents: This marine community has super heated water. It contains white and black smokers. Bacteria are the primary producers and make food through chemosynthesis. Deep sea fish are at the top of the food chain in this environment. This environment could have been the starting point for life on Earth.

Ecological Services:

- "Marine resources and processes that are valued by humans"
- Fisheries (commercial fisheries including crab, urchins, herring, halibut, tuna, rockfish, flatfish, shrimp, salmon)
- Seaweed harvests (Postelsia, Laminaria, Alaria, Porphyra)
- Aquaculture (shellfish in estuaries, potential offshore net-pens for finfish)
- Nursery Habitat (rocky reefs, kelp forest, rocky intertidal, estuaries marshes)
- Coastal Protection (bluffs, kelp forest, rocky reef, estuaries, eelgrass, marshes)
- Ocean Wave Energy (highest potential on CA shoreline)
- Tourism and Recreation (recreational fishing, sightseeing, surfing, hiking, camping, boating, cycling, kayaking, diving, etc.)
- Climate moderation
- CO_2 absorption
- Nutrient cycling
- Waste treatment and dilution
- Reduced storm
- Impact (mangrove, barrier islands, coastal wetlands)
- Habitats and nursery areas for marine and terrestrial species
- Genetic resources and biodiversity
- Scientific information

Economic Services

- Food
- Animal and pet
- Feed (fish meal)
- Pharmaceuticals
- Harbors and transportation routes
- Coastal habitats for humans
- Recreation
- Employment
- Offshore oil and natural gas
- Minerals and Building materials

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Natural Capital Degradation

- Half of coastal wetlands lost to agriculture and urban development.
- Over one third of mangrove forests lost since 1980 to agriculture development and aquaculture shrimp farms.
- About 10% of world's beaches eroding because of coastal development.
- Ocean bottom habitats degraded by dredging and trawler fishing boats.
- Over 25% of coral reefs severely damaged and 11% have been destroyed.

CONCLUSION

Marine ecosystem is the richest source of minerals & habitats, so marine degradation has to be prevented and protected to the greater extent. Human activities affect marine ecosystem as a result of physical and chemical water pollution, over fishing, introduction of invasive species & acidification of water. So such activities should be prevented by making the strict laws by the government. On other hand the awareness programmes should be carried out in different organization like, schools, colleges, hospitals and public sector organization regarding effects of water pollution and its control measures.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Rain tree (*Albizia saman*): A potential lac host and gum producing tree

Article id: 22895

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Rain tree (*Albizia saman*) is a host plant for lac insects (*Kerria* spp.) known for producing a resin called 'lac' which finds application in many industrial sectors. Lac cultivation is an important livelihood for the forest and sub-forest people of the country including Jharkhand, Chhattisgarh, Madhya Pradesh, West Bengal, Maharashtra and Odisha. Rain tree is an attractive, large, semi deciduous popular avenue tree with an umbrella-shaped crown. The tree also yields reddish-brown colored gum from its bark. The gum is of inferior quality and can be used as an adhesive. Recent surveys and past reports suggest that Rain tree may serve as an important host for lac cultivation thorough out India.

INTRODUCTION

The known beneficial insects like honeybees, silkworm and lac insect are nature's gift to mankind which provides additional income to the people engaged in agriculture. In agriculture, insects have many dimensions from harmful pests to beneficial nature. The economically important insects have influenced mankind's life in many ways since time immemorial. The products from these beneficial insects have provided livelihood to lakhs of farmers especially belonging to the down-trodden strata of the society. The best known beneficial insects like honeybees, silkworm and lac insect are nature's gift to mankind which provides additional income to the people engaged in agriculture. Indian lac insect (*Kerria lacca* Kerr.) known for producing a resin called 'lac' (Fig. 1) belong to the family Tachardiidae (=Kerridae), order Hemiptera and are phytosuccivorous and sessile (Fig. 2). Only female lac insects produce lac resin of commerce by ingesting phloem sap from their host plants (Fig 3). Lac cultivation is an important source of income for livelihood of the forest and sub-forest dwellers of Jharkhand, Chhattisgarh, Madhya Pradesh, West Bengal, Maharashtra, Odisha and parts of Uttar Pradesh, Andhra Pradesh, Gujarat and NEH region. It provides employment to both men and women dwelling in forest and sub-forest areas of these states. Lac finds application in many industrial sectors like food, cosmetic and jewelry, electrical and electronics, pharmaceutical, textile, adhesive, varnish, lacquer and paints etc (Fig 4). Common host plants of all India importance are Kusum [*Schleichera oleosa* (Lour.) Oken]; Palas [*Butea monosperma* (L.) Taub.] and Ber [*Ziziphus mauritiana* (Lam)]. Based on the preference of host-plants by lac insect, host plants are classified into 3 categories (i) 'common' hosts or major hosts; (ii) the 'occasional' hosts; and (iii) the 'rare' hosts.

Fig.1. Lac resin

Fig.2. Lac insect encrustation

Fig.3. Female lac insect cell

Fig. 4. Crafts prepared from lac resin

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Rain tree [*Albizia saman* (Jacq.) Merr.] [Family: Fabaceae] is a natural host plant for lac insects (*Kerria* spp.). It is an attractive, large-spreading deciduous tree. It has a low, dense, umbrella-shaped crown, feathery foliage, puffs of pink flowers with a short, usually crooked bole (Fig.5 a-c). Due to its rapid growth habit, it was spread to other parts of the world from Central America for railway fuel. The name rain tree has been attributed to many theories like closing of leaflets from dusk to dawn allowing rain to fall through the canopy to the ground below and a steady drizzle of honeydew from sap-sucking insects etc. (Staples and Elevitch 2006). Tree was introduced in India in 1880 principally as a shade or ornamental tree in streets, parks and in coffee plantations. It is a popular avenue tree and has many other uses like preparation of fruit drink from the pulp of pod, use of decoction of inner bark and fresh leaves to treat diarrhea, stomach-ache, skin problems, eczema and pruritus, fruit decoction as a sedative, seeds for treating a sore throat etc. The tree yields a gum of inferior quality which could be used as a poor man's substitute for gum Arabic and can be used as an adhesive.

Fig.5. a) Rain Tree (*A. saman*); b) Pink flowers & c) Reddish Gum

Fig. 6. Natural population of lac insect on rain tree branches

Apart from this, tree was accepted by lac insect and soon tree was colonized by lac insect to produced lac resin (Fig.6.). Glover (1937) reported rain tree as a host of lac insect from Visakhapatnam (Andhra Pradesh, now Telangana) and Thailand. Now in Thailand rain tree is a popular lac host plant (Takeda 1990). Thangam (1961) utilized rain tree as a minor host for *kusmi* lac in Cumbam range, Madurai district (Tamil Nadu). Mishra *et al*., in 2000 reported occurrence of trivoltine lac insects (identified as *Kerria sharda*) on *Albizia saman* (Jacq.) Merr. from coastal West Bengal and Rairangpur, Odisha. In recent surveys, natural population of lac insect was found on rain tree in most of the regions of Jharkhand, Tamil Nadu and West Bengal (Mohanasundaram *et al*., 2018). Now reports from others researches suggest that rain tree supports natural population of lac insect in Andhra Pradesh, Telangana, Odisha, Madhya Pradesh, Maharashtra, Kerala, Tamil Nadu and Karnataka (Table 1). The lac insect species found on rain tree in Madurai (Tamil Nadu) is identified as *Kerria maduraiensis* a new species of Kerria genus (Ahmad & Ramamurthy, 2014).

Table 1.: Details of lac insects found on Rain Tree during survey

Year	States	Districts/ villages/ places	Lac insect presence	Host Plant	Scientist conducted Survey from ICAR-IINRG, Ranchi
2011-12	Tamil Na du	Madurai	Yes	*Rain tree*	Dr. A Mohanasundaram
2013-14	West Bengal	Kolkata	Yes	*Rain tree*	Dr. J. Ghosh & Dr. A Mohanasundaram
2014-15	Tamil Na du	Salem Krishnagiri Dh armapuriDind igul Madurai	Yes	*Rain tree*	Dr. Vaibhav D Lohot Dr. A Mohanasundaram
2015-16	Tamil Na du	Vellore Tirivanna-malai Kanchipuram Tiruvalluar	Yes	*Rain tree*	Dr. Vaibhav D Lohot Dr. A Mohanasundaram
2017-19	Other states	Andhra Pradesh Telangana Odisha Madhya Pradesh Maharashtra Kerala Tamil Nadu Karnataka	Yes	*Rain tree*	Other Researchers

Besides above a reddish brown to pale yellow colored gummy discharge comes out from stem of rain tree, generally through wounds (Fig. 5c). The gum is considered of inferior quality but could be used as paper adhesives and adhesive for other domestic uses. The gum contains tannin and believed to have medicinal properties descended from bark. The gum is edible and also popular as a poor man's substitute for gum Arabic.

CONCLUSION

Lac cultivation once carried out in 1960s by Thangam in Tamil Nadu has no traces at present. So far around 400 host plants of lac insect are reported and majority of them do not fall under the category of host plants of all India importance (Sharma 1997). Only three host plants Kusum, Palas and ber are commercially exploited for lac resin. Recently *Flemingia semialata*, a bushy host is gaining importance amongst the lac growers. Occurrence of lac insect species on rain tree in several parts of southern states of India and its distribution throughout India, makes rain tree a potential lac host. Based on the above reports we can conclude that rain tree can be a potential host for lac cultivation in humid warmer parts of India. Thus, this host can find a place in the category of major hosts of all India importance. Most of the time, heavy natural settlement of lac insect on rain tree causes death in some of the plants. Tree also yields gum which can be substitute for gum Arabica. Therefore, scientific lac cultivation and gum tapping from rain tree may be initiated and promoted throughout India.

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Management of thrips (*Thrips tabaci* Lindeman) for Garlic production

Article id: 22896

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INTRODUCTION

Garlic *(Allium sativum* L.) is one of the important bulbous crops grown and used as a spice or a condiment throughout Country. It is rich in proteins, phosphorus, potash, calcium, magnesium and carbohydrates. Ascorbic acid content is very high in green garlic.Garlic has been used throughout recorded history for culinary,medicinal use and health benefits. Currently, the interest in garlic is highly increasing due to nutritional and pharmaceutical value including high blood pressure and cholesterol,atherosclerosis and cancer.Thrips (*Thrips tabaci* Lindeman) is a major pest of garlic and cause considerable loss in yield. The nymph and adult of thrips feed leaves by piercing and rasping the leaf tissues and causes lengthwise, silvery stippling or blotching on the garlic leaves, resulting in the loss of chlorophyll and reduced photosynthetic efficiency. Thrips attack garlic at all the stages of crop growth but their count increases from bulb initiation and remain high up to bulb maturity. Thrips can also transmit several plant pathogens in garlic crop that reduce garlic bulb size and quality.They indirectly spread the virus diseases.Thrips damage due to feeding aggravates the infection of fungal disease like purple blotch in field and *botrytis allii* infection in storage. Garlic is vegetatively propagated crop wherein cloves are used as the propagation material.It is prone to a number of viruses which cause degeneration of the planting material due to their systemic mode of transmission. Virus-free planting material provides much higher yield than that of virus infected ones.Unfortunately,planting material being used by the farmers and supplied by various agencies is degenerated one due to viruses and never tested for their freedom from viruses. Thisis the one of major factor for low productivity of garlic in India.

Symptoms

Thrips are swift, pale yellow to brown in colour. Both nymphs and adults suck sap through piercing mouth parts resulting in to silvering, curling and eventually bulb size and weight reduction. Turning and twisting of the leaves and stunting are also common. Thrips cause damage to bulbs in the field itself.

Garlic Crop damage by thrips

Monitoring and population dynamics

Because of small size,egg deposition inside the plant tissue, the tendency to hide in tight space,thrips are difficult to detect before the plant shows symptoms.Knowledge on population dynamics is useful in decision-making process of pest management.Geographical variations are evident in population fluctuations of thrips with temperature and humidity.Heavy rains wash out thrips down to the soil causing a sudden decline in population. Thrips populations come down in the succeeding season in the year whenever rains prolonged beyond their schedule. Population shoots up in January –February in western Maharashtra.

Control Measures of thrips

Cultural

The cultural practices such as removal of weeds around the fields because thrips survive on many other plants and weeds,crop rotation, intercropping, spacing of plant to plant and row to row, doses of fertilizers, irrigation and mulching, etc are important factors for decreasing or increasing the thrips populations in garlic crop.

Biological

Many beneficial organisms prey to harm thrips. Some of these include ladybird beetles, minute pirate bugs, ground beetle, lacewings, hover flies, predatory mites and spiders. Some entomopathogenic fungi are also being investigated for the control of thrips like *Metarhizium insopliae* ,*Verticilium lecani* and *beauveria bassiana*. The *B.bassiana*was foundmost effective when used early at the economic threshold level before large thrips populations built up. The influence of temperature on the infection process is very important. The temperature at which *Metarhizium* infecting adult thrips, is about 23ºC and decreases at temperature of 3 to 5 ºC, increase the time to death of the insect about a day. *Beauveria* is used as a contact myco - insecticides but survives a relatively short period of time when exposed on leaf surface.

Botanical

The farmers are extensively using contact and systematic insecticides and also synthetic pyrethroides for controlling the pest including thrips.However, repeated application of same group ofchemicals is not a desirable practice as this could leadto undesirable resistance problems. Foliar spray of neem crude oil@4%,Pongamia crude oil@4%,Dasparni@50ml/L, NSKE (Neem seed kernel extract) @ 5% at 10 days interval proved better for thrips management.

Pheromone Traps

It is difficult to control these pests because of its small size and cryptic habits. Determination of colour preference of crop pests may help to develop pest traps using such attractive colours, thus providingopportunities for pest control by integrating specific colours into crop management methods. This helps either to reduce or avoid the use of synthetic pesticides and hence helping to avoid the buildup of pesticide residues in the environment and food. Coloured sticky traps could be a simple and low cost method for determining the relative abundance of insects. It is needed forthe determination of colour preference of thrips to get maximum catches of the insect. The sticky traps found effective for thrips control in garlic crop are yellow, greenand blue (size 20 x15 cm) @1 trap per 4 m^2 fixed at 15 cm above the canopy.

Chemical

Chemicals are the most common practice for thrips management. Spraying of Fipronil @1.0ml/L, Carbosulfan @2.0ml/L, Spinosad @0.5ml/L and Profenofos@2.0ml/Lat 10 days interval after appearance of thrips offers best control of this pest.Alternate use of chemical group to avoidresistance problemand adding thesilica basedsticker @0.50ml/L during the spray was found better for thrips management.

IPM Practices

Integrated pest management is the careful consideration of all available pest control technique and appropriate measures to discourage the development of pest population and keep pesticides and other interventions to levels that are economically justified and reduce risks to human health and the environment.Summer deep ploughing, Soil application of neem cake @ 3.0 tonnes/ha, planting of barrier crops,(outer row of maize + inner row of wheat on all 4 sides of the plot) at least 7-10 days before garlic planting, wheat may be planted closely and maize at 25 cm interval, no gap should be there between maize plants. Use of sprinkler irrigation reduces thrips population considerably as compared to drip and surface irrigation, use regular irrigation to crop and avoid water stress condition, avoid excess use of nitrogenous fertilizer, spray of fipronil@1.0 ml/L at 30 DAP, spray of neem oil 3.0ml/L at 45 DAT, spray of spinosad@0.5 ml/L at 60 DAT ,spray of *B.bassiana*@ 5.0 g/L at 70 DAP,spray of profenofos@2.0ml/L at 80 DAPspray was found better for thrips management.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Cultivation of *Cassia auriculata* as a Hair Conditioner and Neutral Henna in Rainfed Farming System - Potentials and Prospectus

Article id: 22897

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***Cassia auriculata*, Linn is one among them which yields natural golden hair dye through leaf powder and yellow dye for textile colouring through young flower buds. This is a highly multipurpose perennial leguminous shrub; indigenously growing drought tolerant hardy shrub commonly grown in entire Aravalli hill tracts of Rajasthan, Gujarat, Tamil Nadu, Karnataka, Andhra Pradesh, Madhya Pradesh, Maharashtra widely used as traditional medicine to cure diabetics by the rural peoples. Now days, this plant is highly valued for herbal hair dyes, it yields natural golden blonde colouring to hair through the dried leaf powder. Yellow colour dye also extracted from young flower buds by textile dyeing industries. Apart from that, in south India, this species is widely used as a nutrient-rich green leaf manure source for their agriculture especially rice fields. Each plant gives 3 to 5 kg of green leaves annually and lopping was used as green leaf manuring. Cultivation of *C.auriculata* is highly amenable and imperative as an intercrop in dry land agroforestry systems to utilize the non-arable waste and degraded lands.**

INTRODUCTION:

A major reason for practicing dryland forestry and agroforestry farming systems is involved with domestication of multipurpose leguminous plant species specifically for degraded soil for enhancing soil productivity (ICRAF, 2000). The Multipurpose legume shrub species are deliberately associated with the agricultural environment because of their specific use. Over the last decade or so, a large number of new initiatives were taken to strengthen the policy and programmes in the relevant sectors which include agriculture, environment and forests, and other initiatives for addressing food production, rural employment generation, women upliftment, preventing and reversing land degradation as also the associated issues of human development, which are inextricably interlinked with sustainable development of the country. India harbours a wealth of useful germplasm resources and there is no doubt that the plant kingdom is a treasure-house of diverse natural products. One such product from nature is the dye. In India, there are more than 450 plants that can yield dyes. In addition to their dye-yielding characteristics, some of these plants also possess medicinal value (Siva,2003). Though there is a large plant resource base, little has been exploited so far. Due to lack of availability of precise technical knowledge on the extracting and dyeing technique, it has not commercially succeeded like the synthetic dyes. Although indigenous knowledge system has been practiced over the years in the past, the use of natural dyes has diminished over generations due to lack of documentation. Also, there is not much information available on databases of either dye-yielding plants or their products. *Cassia auriculata*, Linn is one among them which yields natural golden hair dye through leaf powder and yellow dye for textile colouring through young flower buds. The use of natural dyes is the safest way because they are not only eco-friendly but also prevent environmental pollution. Natural dyes are biodegradable, non-toxic, aesthetically appealing and may serve a better alternative to generate employment and utilize the wastelands. Natural dyes are obtained from plant, animal and mineral resources. Nowadays, fortunately, there is increasing awareness among people towards natural products. Due to their non-toxic properties, low pollution and less side effects, natural dyes are used in day-to-day use food and cosmetic products. Kumar *et al.* (2004) opined that the revival and use of vegetable dyes is possible by encouraging research on various herbs and shrubs with regards to their agronomic practices, chemical evaluation and purification of dyes and by proper cultivation of potential dye yielding plants around 7.5 million hectares of marginal and waste lands available in India.

Brief Description:

Cassia auriculata L. Synonym of *Senna auriculata* (L.)Roxb. (Common Name- Tanner's Cassia), it is a multipurpose legume shrub in the subfamily Caesalpinioideae. It is commonly known by its local names Indian senna/ Avartakgi/ Avaram/Tangedu.

Kingdom	***Plantae***
Order	*Fabales*
Family	*Fabaceae*
Sub-Family	*Caesalpinioideae*
Tribe	*Cassieae*
Genus	*Cassia*
Species	*C.auriculata*
Common Name	*Tanner's Cassia/ Indian Senna*

This is a perennial shrub, growing to a height of 60 to 150 cm sometimes it reaches 2-3 m. The plant leaves are alternate, stipulate, paripinnate compound, very numerous, closely placed, rachis 8.8-12.5 cm long, narrowly furrowed, slender, 6 pubescent, with an erect linear gland between the leaflets of each pair, leaflets 16-24, very shortly stalked 2-2.5 cm long 1-1.3 cm broad, slightly overlapping, oval oblong, obtuse, at both ends, mucronate, glabrous or minutely downy, dull green, paler beneath, stipules very large, reniform-rotund, produced at base on side of next petiole into a filliform point and persistent. Its flowers are irregular, bisexual, bright yellow and large (nearly 5 cm across), the pedicels glabrous and 2.5 cm long. The racemes are few-flowered, short, erect and crowded in axils of upper leaves so as to form a large terminal inflorescence (leaves except stipules are suppressed at the upper nodes). The 5 sepals are distinct, imbricate, glabrous, concave, membranous and unequal, with the two outer ones much larger than the inner ones. The petals also number 5, are free, imbricate, crisped along the margin, bright yellow veined with orange. The anthers number 10 and are separate, with the three upper stamens barren; the ovary is superior, unilocular, with marginal ovules. The fruit is a short legume, 7.5–11 cm long, 1.5 cm broad, oblong, obtuse, tipped with long style base, flat, thin, papery, undulately crimpled, pilose, pale brown. 12-20 seeds per fruit are carried each in its separate cavity (Fig.1).

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Distribution, growth habit and harvesting:

An Indo-Malaysian species which is native to India and Sri Lanka and introduced to various parts of Southeast Asia, it is found in the dry zones of peninsular India as far as the northern parts of Rajasthan. Typically found along roadsides and various other open degraded habitats and in scrub forests, usually on stony, dry or sandy soils. One of the indigenously growing hardy shrub commonly used by the rural people in Rajasthan, Gujarat, Tamil Nadu, Karnataka, Andhra Pradesh, Madhya Pradesh, Maharastra. It is also grown in hedges and gardens in the northern parts of India from West Bengal to Haryana for decorative purpose.

Often gregarious having beautiful bright large yellow flowers. For green leaf purposes, the shrub should be kept low by pruning or lopping at a height of 0.50-1.0 m. The shrub can be pruned two or three times / year and it withstand high intensity of repeated cutting and allow growing like bush. Within two years after planting, the plants are ready for cutting. Each plant gives 3 to 5 kg of green leaves annually (KAU,2011). During flowering stage, is can topped (stem and branches cut) and lopping used for green leaf maturing. Green manuring are low cost and effective technology in minimising cost of fertilizers and safeguarding productivity (KAU 2011). This plant has beautiful yellow flowers and produce abundant seeds. Propagation is sowing and transplanting. It easily propagated by direct sowing seeds. Data regarding its propagation by cutting is not available till date. As an Indian medicinal plant gets its flower from the month of October till May and the fruits of this plant mature from the month of January till June and this depends on the local environment. It also possesses very smooth barks which are reddish-brown in colour. The 2-3 year old plant is ready for harvest. This shrub yields considerable amount of fuelwood per harvest/cutting and easily re-sprouting through coppice growth. This plant fuel wood contains high calorific value; it can withstand annual high intensity coppicing. In Gujarat and the neighbouring states, Acacia nilotica is extensively used as a tree crop in wasteland and village common land afforestation with spacing of 2.5 m x 2.5m or 3m x 3m. These areas are always having acute shortage of fuel wood in the countryside and these common lands to site for poor peoples' cattle foraging site. So introduction of Cassia auriculata as an understory fuelwood crop with *Acacia nilotica* can immensely serve purpose to reduce fuelwood and fodder shortage in rural sector. The plant have habit initiate flowering at two seasons per year. In some place flowering can be observed throughout the year. So this kind plant is highly useful for initiate apiculture forestry systems. Dry flower powder is also having high market value by many antidiabetic herbal tea producing companies as well as an important ingredient in many cosmetic preparations.

Why it is called neutral henna?

Cassia auriculata: The reason for using *Cassia auriculata or Senna auriculata* as the main ingredient in herbal hair products is that it stimulates natural hair growth by increasing the blood flow in the scalp and thus preventing hair fall. This miraculous medicinal herb is antibacterial in action and treats the scalp disorders and acts as a tonic for making hair shiny, voluminous and filled with beautiful fragrance. It can also be used alone as a conditioner for hair. The famous *Cassia* Herbal hair treatment powder is 100% Natural and Herbal, it is designed to fight hair fall and make hair strands strong and dense. Magical Ingredients of Cassia Herbal Hair Treatment: The effectiveness of Cassia Herbal Hair Treatment and Herbal Hair wash

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lies in the key ingredients present in these products. *Cassia auriculata* dried leaf powder used as a netural henna hair dye/conditioner to create a golden blonde tone on grey or blonde hair. It will not make your hair colouring but it makes your hair shiny and conditioning with light golden blonde shade. Hence, it famous known as a *neutral henna*. On lighter hair it may give you blonde glints and soften hard looking grey hair. Mostly demand were increased day by day from western world people because they prefer golden shade blonde than dark black (*Indigofera tinctoria*)/ red hair dye (*Lowsonia innermis*). Hence, it have immense marketing value through export in western countries like Europe, America, Australia etc.,

Source : Adopted from Web as an available product in the Indian market

Scope for Integrating of *Cassia Auriculata* in agroforestry Systems under rainfed condition

The special features of Cassia auriculata for dryland or wasteland adaptability can be i) high germination and survival at nursery and transplantation site ii) fast growing and easy establishment rate, iii) Good root and shoot system, iv) High reproductive fertility, v) Enhancement of soil nutrient status vi) Good coppicing ability, vii) Recover fast from damages viii) Meet the local requirement of fuel, dye, tannin and medicines.

In Gujarat and the neighbouring states, *Acacia nilotica* is extensively used as a tree crop in wasteland and village common land afforestation with spacing of 2.5 m x 2.5m or 3m x 3m. These areas are always having acute shortage of fuel wood in the countryside and these common lands to site for poor peoples' cattle foraging site. So introduction of Cassia auriculata as an understory fuelwood crop with *Acacia nilotica* can immensely serve purpose to reduce fuelwood and fodder shortage in rural sector (Banerjee 1989). Shilpi Rijhwani *et al.,* (2015) that on basis of efflux of biomolecules and proline content in heat and drought tolerances*, C. auriculata* may thus be regarded as the most drought tolerant species. Thus, it can be utilized for afforestation and eco-restoration operations in the drylands.

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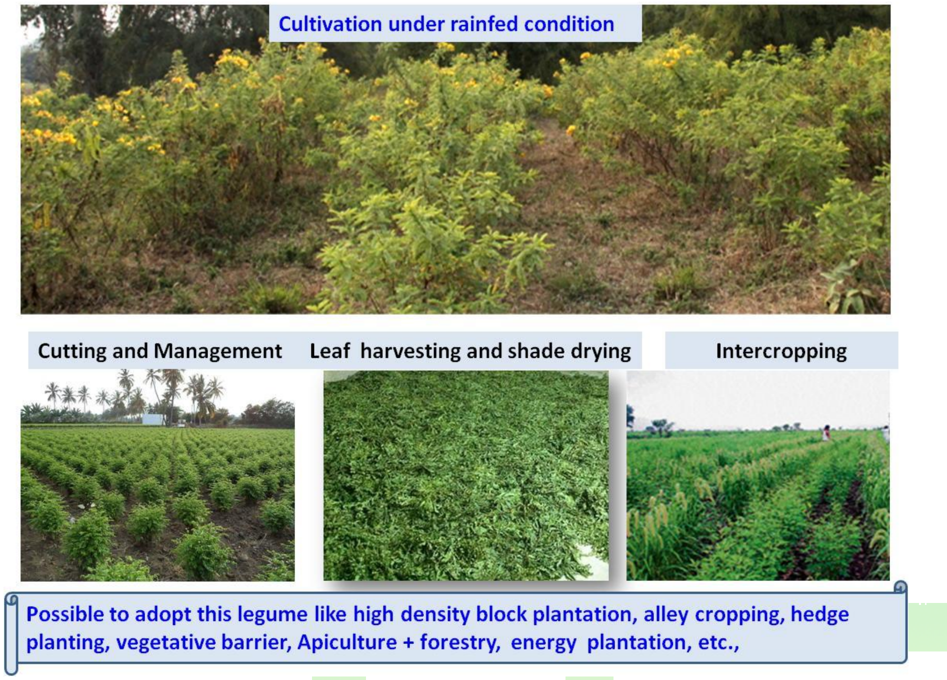

So for such a multiple utility shrub species has not been attempted for its important by people in resource poor regions. Now days, there is high scope for cultivating this masticator shrub under commercial plantation / intercrop in agroforestry systems for potential utilization of non-arable waste and degraded lands to get economic return through leaves, flowers, bark and fuelwood. This wonderful native plant has many medicinal and commercial uses which can be utilized after value addition. It can also fit into afforestation, agro-forestry and soil reclamation programmes as a legume species. It is a potential shrub in agro-forestry system and recommended for sandstone rocky sites. Plants grow on lime-rich soils are richer in tannin than those grow on red loam and gravelly soils. It can also be grown as hedge plant due to its non-palatable nature. It is cultivated as shelter and wind break shrub in the desert of Rajasthan for wind erosion control for enhancing the productivity of degraded lands.

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Management of Powdery Mildew Disease for Quality Production in pepper

Article id: 22898

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INTRODUCTION

Pepper (*Capsicum annuum* L.) belong to the family Solanaceae is mainly cultivated for green fruits as table purpose and dry chilli as spice and is popularly known as "red pepper". It is one of the most popular and highly remunerative annual herbaceous vegetable crop. In India, chilli is extensively cultivated in Andhra Pradesh, Telangana, Madhya Pradesh, Karnataka, West Bengal, Odisha, Maharashtra and Tamil Nadu. In India, around 775 thousand hectares with annual production of 1492 thousand metric tonnes which accounts for 25% of the world production. Chilli suffers from many diseases caused by fungi, bacteria, viruses and nematodes. Among the fungal diseases, powdery mildew, leaf spot and anthracnose or fruit rot are the most prevalent ones. The powdery mildew caused by a fungus namely *Leveillula taurica* is a major constraint in chilli production caused heavy yield loss ranging from 14 to 30% due to severe defoliation and reduction in photosynthesis, size and number of fruits per plant .This disease is very common from November to February.

Causal oraganism: Powdery mildew disease is caused by *Leveillula taurica* belonging to family Erysiphaceae, order Erysiphales,class Plectomycetes and sub. division Ascomycotina .

Symptoms

Leveillula taurica infects the lower leaf surface as small, whitish powder -like colonies. The upper surface of the foliage develops yellow spots that become more prominent as *L. Taurica* develops. There are no symptoms on either the fruit or root tissues. As the disease develops, the older colonies of the fungus may turn into dirty white colour, with age. The severely affected leaves turn yellow, then brown and fall off. Generally, the older leaves are affected first and the disease gradually moves up the plant. Crop yield and fruit quality may be reduced through loss of foliage. The disease is favoured when large day/night temperature and humidity fluctuations occur, which promote periods of leaf wetness. Development of *L.taurica* is favoured by warm (25°C) and dry (less than 80% RH) days followed by humid (greater than 85% RH) nights. Temperature of 25°C is associated with a higher rate of disease development than temperatures of 18–20°C. Young plants are less susceptible than older plants. Other factors such as close plant spacing and luxuriant plant growth arising from high nitrogen levels are likely to foster greater disease development.

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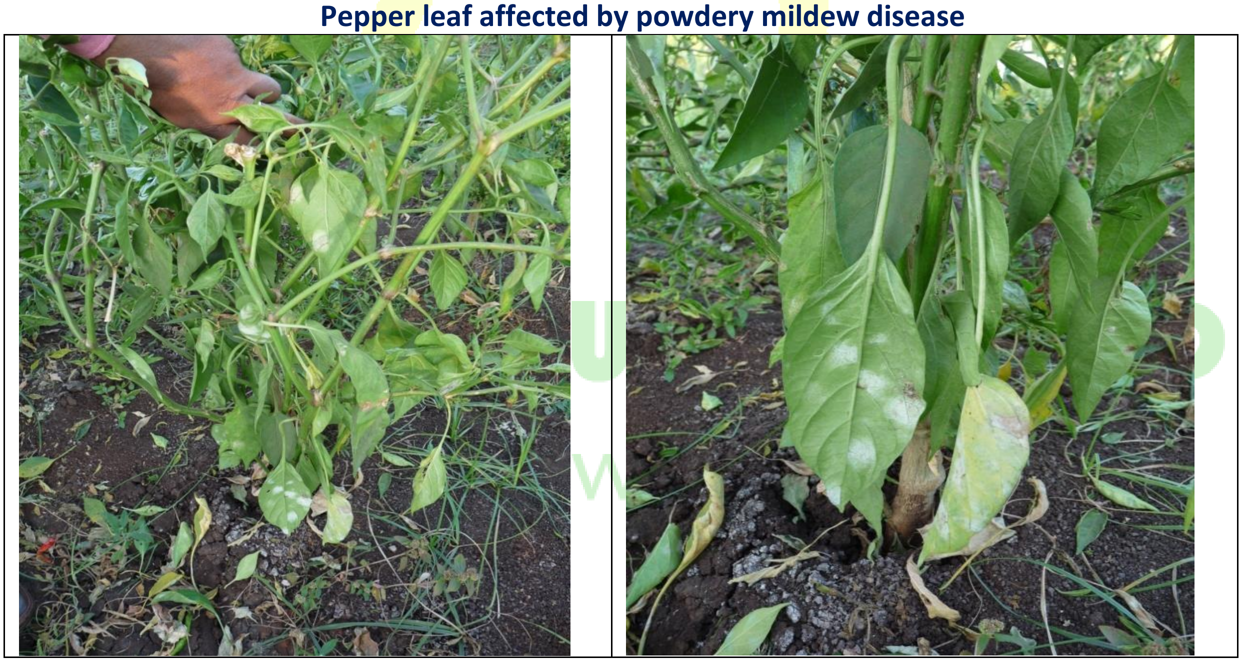
Pepper leaf affected by powdery mildew disease



Leaf defoliation due to severe attack of powdery mildew disease

Control Measures

a) Cultural

With the wide host range of the pathogen and wind dispersal of the spores, crop rotation and management of nearby weed hosts may not provide an adequate level of control without using other means of control. Low light and high humidity favour the development of powdery mildew on peppers, so cultural practices that minimize these conditions can help lower disease severity. Hence, select sites with well-drained soils and good air circulation. Adjust planting densities and row orientation to promote good air circulation and light penetration into the canopy. Avoid excessive fertilization that would result in overly dense canopies. In greenhouse production, increasing the temperature in the greenhouse can lower humidity levels and slow disease development.

b) Biological

The use of bio - control agent like *Bacillus subtilis* and *Trichoderma harzianum* @5.0g/L spray at 7 days intervals for best control of powdery mildew after symptoms appear.

c) Chemical

Several fungicides like.Difenconazole@ 2.5g/L or Azoxystrobin @1.0ml/L or Hexaconazole @ 1.0ml/L or Tebuconazole@1.0ml/L and sulphur@2.0gm/L with silica bases stickler spray at 10 days intervals effectively control the powdery mildew disease in pepper.

Caution**:** Chemical spry shall be stop 3 days before of harvesting.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Advanced horticulture with Artificial intelligence(AHAI)

Article id: 22899

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Artificial intelligence is the process of making intelligent machine by the human. It comes under broad domain of computer science that emphasizes the creation of tangible and intangible systems which not only behave intelligently but also display behaviour to the same level as human beings think and act, achieving human like performance in all cognition tasks using purely logical reasoning. The essential elements of AI working are based on learning from historical data and the process decision that is quick and efficiency. Machine learning is a subset of AI where tools are built to create the Artificial intelligence. An AI based automatic system has been designed and developed for identifying the most matured pineapple. This technique involves computer vision and machine learning techniques based algorithm using Haar-like features. Python language has been used to evaluate the features of a matured pineapple. The developed system field tested and found to succeed the identification of 93% the correct fruits. AI technology is rapidly rectifying the problems while recommending specific action that is required to overcome the problem. AI is efficient in monitoring the information to find solutions quickly. The agriculture and horticulture sector is undergoing digital transformation with huge potential to producers and consumers. Introduction of digital agriculture, industrialisation and mechanisation of production processes, connectivity and data management are set to unleash the next revolution in the history of agriculture and farming.

INTRODUCTION:

The term ‘Artificial Intelligence’ was coined by John McCarthy in 1950. Artificial Intelligence is the process of making intelligent machine by human. The essential elements of AI working are based on learning from the historical data, and the process decision that is quick and accurate. Why Artificial Intelligence? It is seen as opportunity in difficult situations/problems particularly that cannot be solved well by humans as well as traditional computing structures. The problems related to the following factors:

- Climate change
- Population growth
- Land degradation
- Low irrigation efficiency
- Biotic and abiotic stresses
- Food security due to large post- harvest losses

APPLICATION OF AI IN HORTICULTURAL SECTOR

1. AI provides more efficient ways to produce, harvest and sell essential crops.
2. AI implementation emphasis on checking defective crops and improving the potential for healthy crop production.
3. The growth in AI technology has strengthened agro-based businesses to run more efficiently.
4. Used in applications such as automated machine adjustments for weather forecasting and disease or pest identification.
5. AI can improve crop management practices
6. AI solutions have the potential to solve the challenges farmers face such as climate variation, an infestation of pests and weeds that reduces yields.
7. It wouldn't eliminate jobs of human farmers rather it will improve their processes

AI IN SHAPING THE FARMS OF THE FUTURE

• **Drones** – Providing new ways of increasing crop yields through in-depth field analysis, long-distance crop spraying and high-efficiency crop monitoring, drone technology is quickly becoming invaluable for farmers.

• **Driverless tractors** – Combining ever-more sophisticated software with 'off-the-shelf' technologies such as sensors, radars and GPS systems, farmers will soon be able to hand this century-old machine over to robots.

• **Automated irrigation systems** – Thankfully, though, automated irrigation systems are designed to utilize real-time machine learning to constantly maintain desired soil conditions to increase average yields

• **Crop health monitoring** – Conventional crop health monitoring methods are incredibly time-consuming and are generally categorical in nature.

CURRENT APPROACHES & ACHIEVEMENTS OF AI IN HORTICULTURE:

1. Blue River Technology – Weed Control:

Controlling weeds is one of the topmost concerns for farmers where an estimated 250 species of weeds have become resistance to herbicides. A California- based startup company developed a robot called "See & Spray" which reportedly leverages computer vision to monitor and precisely spray on weeds. Precision spraying can help prevent herbicide resistance. It precisely sprays fertilizers directly to the plant that needed it. This could save about 90% amount of herbicide that would be needed to spray in the entire field.

2. Harvest CROO Robotics – Crop Harvesting:

Lack of laborers has reportedly led to millions of dollars of revenue losses. In June 2017, Florida-based Wish Farms announced its implementation of Harvest CROO Robotics strawberry harvester (Fig 1) in the summer of 2017 to help strawberry farmers pick and pack their crops.

3. AI -Driver Less Tractor:

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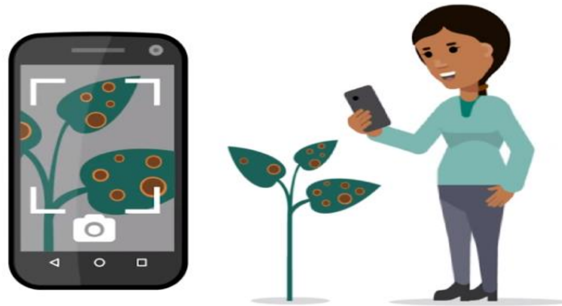
Driverless tractor has been introduced using ever-more sophisticated software coupled with off-the-shelf technology (sensors, radar, and GPS), the system which allows an operator working a combine to set the course of a driverless tractor. For the first time, Case IH and New Holland both introduced their new autonomous tractors at 2016 Farm Progress Show.

4. Crop and Soil Health Monitoring AI

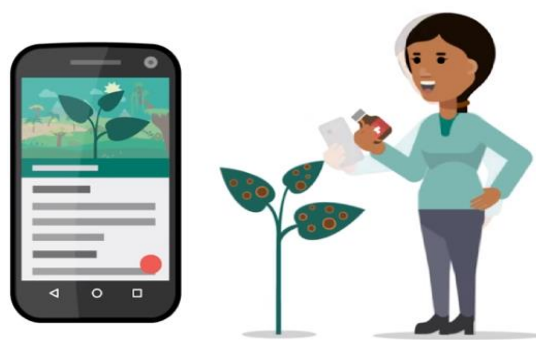
A. PEAT – A machine Vision for Diagnosing Pests / Soil Defects:



Berlin-based agricultural tech startup PEAT, has developed a deep learning application called *Plantix* that reportedly identifies potential defects and nutrient deficiencies in soil. Analysis is conducted by software algorithms which correlate particular foliage patterns with certain soil defects, plant pests and diseases. The company claims that its software can rapidly achieve pattern detection with an estimated accuracy of up to 95%.

a. Steps for Health Check of a crop:

- Take a picture of your crop.
- *Plantix* analyses it within the blink of an eye and reports detailed information about the plants species and its potential diseases, their cure as well as customized prophylaxis suggestions.(Fig.:2)



b. AI- powered farmer support

- Each disease reveals itself via a certain pattern on the leaves. AI- based image recognition enables Plantix to recognize these patterns.
- Though the latest machine learning innovations and an average input of 14,000 pictures per day.
- Plantix increases its diversity and becomes more accurate with each single upload (Fig.:3)

What's Included?	Disease Risk Test	Fertility Test	Comprehensive Test (*Includes Disease Risk and Fertility*)
Bacterial Pathogen	√		√
Fungal Pathogen	√		√
Pathogen Detection	√		√
Disease Risk Report	√		√
Nutrient Cycling (N, P, & K)		√	√
Fertility Indicators		√	√
Fertility Report		√	√

B. Trace Genomics- Machine Learning for Diagnosing Soil Defects

Similar to the Plantix app, California-based Trace Genomics, provides soil analysis services to farmers. Lead investor Illumina helped develop the system which uses machine learning to provide clients with a sense of their soil's strengths and

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weaknesses. After submitting a sample of their soil to Trace Genomics, users reportedly receive an in-depth summary of their soils contents. (Table 1)

5. FarmShots-Satellites for Monitoring Crop Health and Sustainability

Based in Raleigh, North Carolina, FarmShots is another startup focused on analyzing agricultural data derived from images captured by satellites and drones. Specifically, the company aims to "detect diseases, pests, and poor plant nutrition on farms." The company claims that its software can inform users exactly where fertilizer is needed and can reduce the amount of fertilizer used by nearly 40 per cent. Hyperspectral imaging and 3D Laser scanning are capable of rapidly providing enhanced information and plant metrics across thousands of acres with the spatial resolution to delineate individual plots and/or plants and the temporal advantage of tracking changes throughout the growing cycle.

6. SkySquirrel Technologies Inc. - Drones and Computer Vision for Crop Analysis

SkySquirrel Technologies Inc. is one of the companies bringing drone technology to vineyards. The company aims to help users improve their crop yield and to reduce costs. Users pre-program the drone's route and once deployed the device will leverage computer vision to record images which will be used for analysis. SkySquirrel uses algorithms to integrate and analyze the captured images and data to provide a detailed report on the health of the vineyard, specifically the condition of grapevine leaves.

7. aWhere - Satellites for Weather Prediction and Crop Sustainability

'aWhere', a Colorado based company uses machine learning algorithms in connection with satellites to predict weather, analyze crop sustainability and evaluate farms for the presence of diseases and pests. Company provides its users with access to over a billion points of agronomic data on a daily basis. Data sources include temperature, precipitation, wind speed, and solar radiation, "along with comparisons to historic values for anywhere on the agricultural earth."

8. Automated Irrigation system

Advantages of using automated irrigation system are:

- Reducing production costs, making the industry more competitive and sustainable.
- Maintaining (or increasing) average yields.
- Minimizing environmental impacts.
- Maintaining desired soil water range in the root zone
- Low labour input
- Substantial water saving

Limitation of artificial intelligence in horticulture

- Lack of familiarity with high tech machine learning solutions in farms across most parts of the world
- Cost is a big challenge
- AI systems also need a lot of data to train machines and to make precise predictions

CONCLUSION

AI can be appropriate and efficacious in agriculture sector as it optimizes the resource use and efficiency. It solves the scarcity of resources and labour to a large extent. Adoption of AI is quite useful in agriculture. Artificial intelligence can be technological revolution and boom in agriculture to feed the increasing human population of world. Artificial intelligence will complement and challenge to make right decision by farmers.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Diseases of Rose and their Management

Article id: 22900

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Rose (*Rosa* spp.), belonging to the family Rosaceae, is the most well-known and beloved ornamental plant worldwide. It is cultivated for cut flowers, loose flowers, essential oil, landscaping and various other purposes. Roses are prone to many serious diseases. The important ones are described below along with control measures.

Die back- The disease is caused by *Diplodia rosarum*. Some other fungi like *Colletotrichum* sp. have also been associated with this malady. The disease appears in maximum severity following pruning of canes after monsoon and causes the death of the plant from top downwards. Blackening of twigs below the pruned surface starts and extends gradually further down killing the whole plant. Older and weaker plants are more prone to the attack as compared to younger and vigorous ones. Browning of internal tissues is observed in the stem and roots of the dead plants. The pathogen gets entry into the host tissue through the injury caused by pruning and afterwards by the wound caused by the digger wasp.

The common control measure is to cut away the affected stem and burn it. The secateur should be disinfected with spirit. Cut ends and a portion of 2.5-3.0 cm further below the shoot is to be immediately coated with a paste containing 4 parts copper chloride, 4 parts red lead and 5 parts of linseed oil. Treatment with rogor (2ml/l) controls the wasp. The cut should be oblique to prevent the accumulation of water. Some systemic fungicides like Bavistin (0.1%) may also be used as spray and soil drench.

Black spot- This is a fungal disease caused by *Diplocarpon rosae* syn M*arssonina rosae*. The disease is characterized by formation of dark brown circular spots on both sides of the leaves. The spots later coalesce and the leaves become yellow and fall. Numerous, small raised dot-like bodies representing the fruiting bodies of fungus can be seen on the spots There is drastic reduction in the size and number of flowers. Sometimes new leaves are produced and these may also become affected. Leaf buds are not properly developed and flower buds are also affected.

The control measures include removal and destruction of infected canes, maintaining good sanitation. Fungicides like benlate (0.1%), bavistin (0.1%) may be used.

Powdery mildew- This disease is caused by fungus *Podosphaera pannosa*. The fungus appears when the days are warm and nights are cool. Almost all aerial parts of the plant are affected including flower buds and blooms. White powdery growth of the fungus appears on young leaf curl exposing the lower surface on which blister-like patches are formed. Infected leaves may be distorted and some leaf drop may also occur. Since plant vigour is checked, new shoots get distorted, affected flower buds either fail to open or may produce poor-quality flowers.

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Sanitation is important to reduce the source of infection. All the infected leaves and branches should be cut away and burnt. The disease spreads quickly as spores are carried by wind. Application of sulfur dust controls the disease; but most of the rose cultivars are liable to sulphur injury, particularly during hot days. Fungicides like benlate (0.1%), bavistin (0.1%), karathane (0.1%) provide fairly effective control if sprayed at 10 to 14 days intervals.

Rust- It is the most common disease in warm humid areas and is caused by the fungus *Phragmidium mucronatum*. It is characterized by the presence of reddish-orange pustules on petioles and leaflets. The colour of the pustules change to black when spores are formed. In severe cases of infection, defoliation occurs and flower production is reduced.

Diseased leaves and plants should be destroyed. Good air circulation should be provided. Spraying with calixin (0.1%) at 15-day intervals controls the disease.

Stem blight- Stem blight is also caused by the fungus responsible for die back. Several tan-coloured spots appear on the stems, particularly in older plants which coalesce together and spread to the whole bark. Older plants are more susceptible than younger ones.

Regular sprays of captan minimizes the disease infection.

Alternaria leaf spot- Leaf spot caused by *Alternaria alternata* results in heavy loss during rainy season.

Spraying at weekly intervals with bavistin (0.1%) or copper fungicides controls the infection.

Rose wilt- It is caused due to infection with a virus *Marmor flaccumfasciens*. The first symptom appears in the form of recurving of leaflets at the tip of brittle young shoots. Leaves gradually turn yellow and defoliation occurs. The stem may also be infected and plant may also die.

Affected plants should be uprooted and burnt. Control of aphids, which transmit the disease, helps to keep off the disease.

Rose mosaic virus- It mostly affects greenhouse roses. Chlorotic areas along the midribs of the leaflets and localized distortion are common symptoms. Sometimes ring and watermark pattern also develop. Another strain of this virus causes brighter and light yellow patterns. Diseased plants should be destroyed and never used for propagation. Infected plants become weak and are more sensitive to damage caused by other stresses, such as drought or low temperatures.

Healthy plants without any mosaic symptoms should be planted. Infected plants should be removed and destroyed.

Crown gall- This disease is caused by a soil-inhabiting bacterium, *Agrobacterium tumefaciens*. The symptoms are rounded galls, or swellings, that occur at or just below the soil surface on stems or roots. The galls are light green or nearly white when young. As they age, the galls darken and become woody, ranging in size from small swellings to areas several inches across.

The galls disrupt the flow of water and nutrients travelling up from the roots and stems, thus weakening and stunting the top of the plant.

Disease-free roses should be selected. Injury to the roots and crown of the plant during planting and cultivation should be avoided because the bacteria enters through fresh wounds. Infected plants should be removed as soon as galls are observed and the soil should be discarded from the area where the infected plant was located. All cutting and pruning tools that have been used near crown gall should be disinfected.

Other diseases- The rose plants are affected by several other diseases of minor importance. They include Anthracnose (*Elsinoe rosarum*), black mold (*Chalaropsis thielavioides*), botrytis blight (*Botritis cinerea*), leaf spots (*Cercospora puderi*) and downy mildew (*Peronospora sparsa* and *Verticillium albo-atrum*) among the fungal diseases; bacterial leaf spot (*Pseudomonas syringae*) among bacterial disease; Rose Streak Virus, Strawberry Latent Ring Spot Virus, Rose Leaf curl, Rose Spring dwarf among the important viral diseases.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Bio pesticides and Bio stimulants

Article id: 22901

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Bio pesticides-

Biopesticides have been defined as a form of pesticide based on micro-organisms or natural products

Types

- **Microbial pesticides**- which consist of bacteria, entomopathogenic fungi or viruses. Entomopathogenic nematodes are also often classed as microbial pesticides.
- **Bio-derived chemicals**- Four groups are in commercial use: Pyrethrum, rotenone, neem oil, essential oils are naturally occurring substances that control pests and microbial diseases.
- **Plant-incorporated protectants (PIPs)** have genetic material from other species incorporated into their genetic material (*i.e.* GM crops).

Advantages-

- Biopesticides are usually inherently less toxic than conventional pesticides.
- Biopesticides effective in very small quantities and often decompose quickly, and largely avoiding the pollution problems caused by conventional pesticides.

Disadvantages-

- High specificity: which may require an exact identification of the pest/pathogen.
- slow speed of action (thus making them unsuitable if a pest outbreak is an immediate threat to a crop)

Examples-

Bacillus thuringensis-

- Bacteria commonly used as a biological pesticide.
- Toxins have specific activities against insect species of the orders Lepidoptera,(moths and butterflies), Diptera (flies and mosquitoes), Coleoptera (beetles), only at larval stages.
- Effective against European corn borer, tobacco budworm, cotton bollworm, pink bollworm, and Colorado potato beetle etc.
- Bt is most effective against young larvae and usually does not kill adults or other stages of an insect.
- Insects must eat Bt for it to be effective, and good coverage is important.
- Bt is rapidly deactivated by ultraviolet radiation. Applications made in the evening, on cloudy days last longer.

- Applications become inactivated in one to a few days and may need to be reapplied in 3 to 7 days.
- Bt is a microbial biopesticide that is very specific to certain insects. It causes insects to stop feeding in a few hours and usually kills insects in a few days.

Beauveria bassiana-

- It is being used as a biological insecticide to control a number of pests such as termites, thrips, whiteflies, aphids, mites , Mealybugs, Grasshoppers, flies, Stem borers, Different types of beetles and weevils.
- Also for the management of larvae of the diamond back moth and kills only few other types of caterpillars.
- These should not be applied to flowers visited by pollinating insects.
- Beauveria bassiana should be used as prevention rather than a cure. Due to the infection incubation period, it takes several days to kill pests.
- The best practice is to start foliar applications at the beginning of the season, when you receive the plants, or on cuttings before pests first appear.
- *Beauveria bassiana* is a fungus, it prefers a humid environment. So require the relative humidity at 60% or higher during foliar applications.
- Do not spray during dry weather and at high temperature.

Metarrhizium anisoplae-

- This is fungus grows naturally in soil, and causes diseases in various insects by acting as a parasite, thus belongs to entomopathogenic fungi.
- When the spore of this fungus comes in contact with the cuticle (skin) of the target insect pests, it germinates and grows directly in to the inner body of the host.
- Thus it is important to spray like, insect should comes in contact with the insecticide.
- Effective against plant hoppers and bugs, thrips, grasshoppers, borers.
- Also used for Soil Application for root grubs.

Verticillium lecanii-

- Verticillium lecanii is an entomopathogenic fungus.
- Infect aphids, whiteflies, rust fungi, scale insects, spider mites, plant and leaf hoppers and lead to death the host.
- Can be applied with neem cake for better management of root borers.

Bio stimulants

- Biostimulants enhance nutrition efficiency, abiotic stress tolerance, crop quality.
- Also enhance plant development in a number of ways throughout the crop lifecycle, from seed germination to plant maturity. They can be applied to plant, seed, soil to assimilate nutrients and properly develop.
- Increase yield in terms of weight, seed and fruit set.
- Enhance quality, affecting sugar content, color and shelf life.
- Improve the efficiency of water usage.
- Strengthen stress tolerance and recovery.

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Gibberellic Acid

- Generally Gibberellic Acid is mixed along with Bacillus Subtilis for improved results. It is a plant growth promoter and helps to improve plant growth. It increases efficiency of plants to fight diseases.
- Stimulate rapid stem and root growth also increase seed germination rate. So use in the initial crop stages.
- Better results in increasing fruit size.

Seaweed Extract

- This is a natural growth promoting agent. It helps the plants in improving nutrient uptake.
- Best soil conditioner.
- It is an excellent activator.
- It shows plant growth-enhancing properties through metabolic benefits, triggering disease response pathways and increasing stress tolerance.
- enhanced crop yield, improved root structures, improved plant development like flowering and leaf development and fruit set, and enhanced ability to tolerate plant disease and climatic stresses such as cold or drought.
- Minimizes effect of heat, frost.

Plant growth promoting Rhizobacteria-

- Plant Growth Promoting Rhizobacteria (PGPR) are a group of bacteria with various plant growth promoting substances as well as biofertilizers.
- Important role- plant growth promotion, increased yield, solubilization of P (phosphorus) or K (potassium), uptake of N (nitrogen) and some other elements through inoculation with PGPR.
- In addition, inoculation with PGPR enhances root growth, leading to a root system with large surface area and increased number of root hairs.
- PGPR play a vital role in the management of various fungal diseases specially seed borne diseases.

Plant growth promoting Azotobacter-

- Biofertilizer (Azotobacter, Azospirillum, etc) have been identified as an alternative to chemical fertilizer to increase soil fertility and crop production in sustainable farming.
- Play vital role in the N fixation in crops.
- Azotobacter also synthesizes some biologically active substances, including some phytohormones such as auxins, thereby stimulating plant growth and increase the soil fertility.
- They also facilitate the mobility of heavy metals in the soil, thus enhancing bioremediation (Removal of toxic material) of soil from heavy metals, such as cadmium, mercury, lead.
- Generally used for seed treatment, results in highest percentage of seed germination.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Key concept in agripreneurship development

Article id: 22902

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INTRODUCTION:

One in every two Indians relies on agriculture for live hood. Agriculture landscape has changed drastically, since this intervention that a second green revolution is going to need an entirely new approach and an entirely new set of technology. Agriculture today faces many challenges, including globalisation and market liberalisation, food price crises, natural resource depletion, climate change, rapid urbanisation, changing production and consumption patterns, demographic changes, and so on. Many of these directly or indirectly lead to changing markets, and create both opportunities and risks for farmers, especially for smallholders, youth, and women. With a growing recognition of the important role of smallholder agriculture for economic growth and rural development in many countries, market-oriented agriculture appears more prominently on the agenda. We believe entrepreneurs are the key drivers of tomorrow innovations and integral to creating a thriving economy. Agripreneurship is the key in this regard.

Concept of Agripreneur:

Agripreneur defined as "entrepreneur whose main business is agriculture or agriculture related"

Agriculture + Entrepreneur = Agripreneur

Concept of Agripreneurship:

Agripreneurship defined as "generally, sustainable, community-oriented, directly-marketed agriculture. Sustainable agriculture denotes a holistic, systems oriented approach to farming that focuses on the interrelationships of social, economic, and environmental processes".

Agripreneurship refers to entrepreneurship in agriculture. Reynold has defined entrepreneurship is a concept that encompasses transforming an idea or vision into a new business or new venture creation, or the expansion of an existing business, by an individual, a team of individuals, or an established business but entrepreneurship, as opposed to self-employment, is also defined by the spirit of the entrepreneurs.

Types of Enterprises:

Different types of ventures in agri-business

1. **Farm Level Producers:**
   At the individual family point, every family is to be treated as venture, to enhance the production by making best use of the technology, possessions and demand in the market.
2. **Service Providers:**

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For optimising agriculture by every family business, there are diverse types of services requisite at the village level. These include the input borrowing and distribution, hiring of equipment like tractors, sprayers, seed drills, threshers, harvesters, dryers and scientific services such as setting up of irrigation amenities, weed curb, plant security, yielding, threshing, conveyance, warehouse, etc. related opportunities exist in the livestock husbandry sector for providing breeding, immunization, disease diagnostic and treatment services, apart from allocation of cattle feed, mineral combination, forage grains, etc.

3. **Input Producers:**
   There are many flourishing enterprises, which need critical inputs. a few such inputs which can be produced by the home entrepreneurs at the village level are biopesticides, soil amendments, biofertilizers, vermicompost, plants of diverse species of vegetables, fruits, ornamentals, root media for raising plants in pots, production of cattle feed concentrate, agricultural tools, irrigation accessories, mineral mixture and complete feed. There are good openings to support, fishery, sericulture and poultry as well, during sponsorship of critical service amenities in rural areas.
4. **Processing and Marketing of Farm Produce:**
   Well organised management of post-production processes requires higher level of knowledge as well as investment. Such venture can be handled by People's Organisations', either in the form of cooperatives, service joint stock companies or societies. The most successful instances are the dairy cooperatives sugar cooperatives, and fruit growers' cooperatives in lots of States. However, the success of such undertaking is exclusively dependent on the reliability and ability of the leaders involved. Such undertaking needs good specialised support for running the activities as a competitive trade and to contend well with other players in the market, mainly the retail traders and intermediates.

Characteristics of Entrepreneurs Useful For Agripreneurship:

The major characteristics of entrepreneurs that have been listed below by many commentators are useful for even agripreneurship:

i. Self-Confident and Multi-Skilled:

The person who can 'make the product, market it and count the money, but above all they have the confidence that lets them move comfortably through unsheltered waters'.

ii. Confident:

In the face of difficulties and discouraging circumstances.

iii. Innovative Skills:

Not an 'inventor' in the traditional sense but one who is able to carve out a new niche in the market place, often invisible to others.

iv. Results-Orientated:

To make be successful requires the drive that only comes from setting goals and targets and getting pleasure from achieving them.

v. A Risk-Taker:

To succeed means taking measured risks. Often the successful entrepreneur exhibits an incremental approach to risk taking, at each stage exposing him/herself to only a limited,

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measured amount of personal risk and moving from one stage to another as each decision is proved.

vi. Total Commitment:

Hard work, energy and single-mindedness are essential elements in the entrepreneurial profile.

Key Issues of Agriculture to Agri-Business:

The following issues are favorable to promote agripreneurship and agribusiness:

i. Policy Issues:

From absolute control and management of agriculture by Government, today it is being opened to public-private partnerships.

ii. Production Technology Issues:

From input/s oriented technology development for increasing production, today practice based value addition is being promoted.

iii. Quality and Certification Issues:

Demands from consumer/s for better quality have forced Government/s to establish regulatory mechanisms for quality certification.

iv. Logistics and Supply Chain Issues:

Modern retail formats requires efficient and dedicated supply chain and management facilities.

v. Human Resource Issues:

Lack of appropriately trained human resource is today considered as the biggest constraint in conversion of agriculture to agri-business or agripreneurship.

Keys to Success in Agri-Business:

There are no easy answers to agri-business success.

Farmers who have started successful agricultural ventures recommend the following points may be considered:

a) Choose something that you love to do. But it has good market and scope.
b) Create a high quality produce.
c) Start small and grow naturally. Don't try to become millionaire overnight,
d) Make decisions based on good records.
e) Produce based on customers' needs.
f) Establish a loyal customer base and don't fool them.
g) Provide more than just a food, produce or service. Provide an experience.
h) Get the whole family or partner's involvement.
i) Keep informed.
j) Plan for the future. Set goals for your business and establish a plan of action to achieve them.

CONCLUSION:

Agripreneurship is the need of hours to make agriculture a more attractive and profitable venture. It is clear that there is a great scope for entrepreneurship in agriculture and this potentiality can be tapped only by effective management of agri elements such as – soil, seed, water and market needs. An individual with risk bearing capacity and a quest for latest knowledge in agriculture sector can prove to be a right agripreneurs. The agriculture sector has a large potential to contribute to the national income while at the same time providing direct employment and income to the numerically larger and vulnerable section of the society. Agripreneurship is not only an opportunity but also a necessity for improving the production and profitability in agriculture and allied sector.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

The role of non-governmental organizations in extension activities

Article id: 22903

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In recent years, many observers have suggested that agricultural and rural development strategies would benefit from increased collaboration between government research and extension organizations and nongovernmental development organizations, hereafter called GOs and NGOs, respectively. Donors in particular have begun to call for more NGO involvement in programmes that have traditionally been implemented through the public sector, and there has been a recent upsurge of donor interest in direct-funding south-based NGOs.

NGO characteristics

NGOs are defined here as non-membership development-oriented organizations. They are formal and informal membership organizations such as farmers' associations. But even within this definition, there exists wide diversity of origins and philosophy. Some NGOs were set up by left-leaning professionals or academics in opposition to the politics of government or its support for or indifference to the prevailing patterns of corruption, patronage, or authoritarianism. Some are based on religious principles, others on a broadly humanitarian ethos, and yet others were set up as quasi-consultancy concerns in response to recent donor-funding initiatives. Some NGOs reject existing social and political structures and see themselves as engines for radical change; others focus on more gradual change through development of human resources (usually through group formation) to meet their own needs or to make claims on government services; yet others focus more simply on the provision of services (e.g., advice, input supply) largely within existing structures.

NGO Strengths

• The majority of NGOs are small and horizontally structured with short lines of communication and are therefore capable of responding flexibly and rapidly to clients' needs and to changing circumstances.
• NGOs' concern with the rural poor means that they often maintain a field presence in remote locations, where it is difficult to keep government staff in post.
• One of NGOs' main concerns has been to identify the needs of the rural poor in sustainable agricultural development. They have therefore pioneered a wide range of participatory methods for diagnosis3 and, in some contexts, have developed and introduced systems approaches for testing new technology.
• NGOs' rapport with farmers has allowed them to draw on local knowledge systems in the design of technology options and to strengthen such systems by ensuring that the technologies developed are reintegrated into them (Chaguma & Gumbo, 1993).
• In some cases, NGOs have *developed* new technologies such as soya production in Bangladesh (Buckland & Graham, 1990) or management practices such as the sloping agricultural land

technology in the Philippines (Watson & Laquihon, 1993), but more often they have sought to adapt existing technologies, such as PRADAN's efforts in India to scale down technologies developed by government for mushroom and raw silk production and so make them accessible to small-scale farmers (Vasimalai, 1993).

• Undoubtedly, one of the main strengths of NGOs has been their work in group formation. This has been in response to perceived needs at several levels:

(1) To meet the technical requirements of certain types of innovation. Thus, Action for World Solidarity in India worked with grass-roots organizations to achieve simultaneous action in an integrated pest management programme (Satish & Vardhan, 1993).

(2) To manage "lumpy" assets. In Bangladesh, NGOs have helped to organize landless labourers to acquire and operate water pumping technology (Mustafa, Rahman, & Sattar, 1993).

(3) To manage common property resources. Many examples exist of formal and informal associations, often supported by NGOs, which manage irrigation water. land in a sustainable fashion in relation both to technology and the creation of a capacity to make demands on government over, for example, access issues (Femandez, 1993).

NGO Weaknesses

• NGOs' small size means that their projects rarely address the structural factors that underlie rural poverty. Small size, independence, and differences in philosophy also militate against learning from each other's experience and against the creation of effective forums, whether at national or provincial levels.

• Some "fashionable" locations have become so densely populated by a diversity of NGOs that problems have arisen not merely of competition for the same clientele, but of some undermining the activities of others (Ayers, 1992).

• NGOs have limited capacities for agricultural technology development and dissemination and limited awareness of how to create effective demand-pull on government services.

• Some NGOs are more accountable to external funding agencies than to the clientele they claim to serve. Donor pressure to achieve short-term impacts, combined with a lack of cross learning, has led in some cases to the promotion of inappropriate technology, such as protected horticultural systems in the Bolivian Andes (Kohl, 1991).

• Many NGOs place great emphasis on voluntarism. Whilst such concepts as "volunteer extension workers" have great intuitive appeal and reflect widely commended values, they are sometimes promoted at the expense of financially sustainable alternatives.

NGO-GO Configurations for Providing Technical Advice and Feedback

NGO-GO Configurations in Training

Some of the farmer training conducted by GOs is linked more strongly with GOs' programmes and targets than with farmers' needs. Much training is given in a classroom environment, without the practical content necessary to engage farmers' interests. NGOs have sought to work with GOs to address these shortcomings in several contexts:

• In Gujarat, India, the Aga Khan Rural Support Project (AKRSP) identified village training needs through discussions with farmer groups (Shah & Mane, 1993). Initially, AKRSP organized government provision of this training, but the courses were formal in style (lectures in a classroom), and farmers' evaluations showed that they had learned little of practical value from them. In response, AKRSP developed an alternative needs-based training and dissemination methodology which it tested over several areas. Government staff were then brought in to observe, participate in, and finally adopt the methodology. Successful adoption was reinforced by informal networks and exchange of experience at workshops and consultations. AKRSP, along with Myrada (Femandez, 1993), has also been instrumental in training GO staff in participatory methods.

• In a different context, the International Institute for Rural Reconstruction in the Philippines brought together resource people from NGOs and GOs at a one-week workshop, the objective of which was to produce a completed *Agroforestry Resources Training Manual.* The manual is now widely used (Gonsalves & Miclatteves, 1993).

• Clearly, there are also many instances in which NGO staff benefit from the skills which GO staff are able to impart; training in grafting techniques, for instance, has been found useful by a number of NGOs (Giordano, Satish, & Farrington, 1993).

NGO-GO Configurations in Group Formation

Substantial scope exists for GOs to benefit from NGOs' group-organizing skills. In India, for instance, recent modifications to the training and visit extension system now require village-level extension workers to interact with groups of approximately twenty farmers instead of with individual "contact farmers." However, extension workers are not trained in group formation skills, and groups that they form are unlikely - if they survive at all - to become interested in anything other than the testing of immediately available technology. The examples cited above illustrate how NGOs can effectively organize groups around integrated pest management, soil and water management, and the management of common property resources and capital assets.

What extension services can do to further collaborate with NGOs?

The foregoing has several implications for extension services which aim to develop closer links with NGOs:

Explicit recognition of the wide diversity of NGO types will be necessary. Not all Many NGOs seek to support the establishment and growth of membership organizations capable of meeting their technology requirements over the longer term either from their own resources or by creating demands on government services or by a combination of both. Thus in seed supply, Cromwell and Wiggins (1993), for instance, quote numerous examples of ways that NGOs have supported local groups to produce seed, including vegetable and soya bean seed production in Bangladesh, and the multiplication of planting material for potatoes in the Ecuadorian Andes. In other countries (e.g., Nepal, the Gambia) local seed production initiatives have arisen plant breeding focused more fully on the needs of the rural poor, and the facilitation of linkages among the various agencies concerned with seed production and distribution. Some of these efforts see viable commercial arrangements as an essential feature of long-term sustainability.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Thus PRADAN, in India, in an effort spanning several years to support the introduction of chrome-leather tanning by a local group, encouraged links with commercial lending organizations and private leather traders, not least because the latter could give accurate feedback on product quality. In a more complex example of experimenting over several years with several types of women's groups for poultry production, the Bangladesh Rural Advancement Committee finally devised a multitier structure embracing rearing, local feed production, and health care by women paravets. These women drew on government for the necessary vaccines, earned a living by charging for injections, and provided elements of the extension function by giving advice on management and nutrition to those who paid for vaccinations will be willing to enter into a collaborative "service delivery" relationship with government, and those that do will do so only if GOs have something to offer appropriate to their clients' needs.

• Close interaction will be impossible if extension departments expect NGOs merely to assist in fulfilling preset targets such as the achievement of a given number of demonstrations of a given kind each season.
• Very specific efforts will have to be made to convey both feedback on existing technologies and NGOs' requirements for new technologies to researchers.
• GO and NGO staff can jointly participate in training courses (ideally led by a joint team) in the action-oriented methods such as participatory rural appraisal favoured by NGOs.
• Depending on their philosophy, NGOs are concerned to develop local capacities for experimentation which build solely on farmers' indigenous knowledge or on this and relevant "outside" ideas.

CONCLUSION

The examples now becoming available offer wider lessons on ways that NGOs and extension services can work in a mutually reinforcing fashion. Predictably enough, it is the group-organizing and human resource development skills of NGOs which have tended to complement the technical skills and facilities available to government. Less predictable are the types of interaction that might evolve in specific settings: much appears likely to develop on an ad hoc basis in response to the individual characteristics of NGOs and the settings in which they work. However, it is becoming increasingly clear that a formal forum is required for certain types of interaction, including training, the joint planning of research and extension agenda, and the securing of joint management agreements for soil and water, fodder, and grazing resources. The task for the coming decade will be to develop these in ways which are nonthreatening both to the organizations involved and to the informal interaction they already undertake and, as a prior requirement, to develop the mutual trust and awareness of each other's activities on which formal interaction depends.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Post harvest practices of banana: An evergreen fruit

Article id: 22904

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Banana is one of the most appreciated fruit all over the world because of its multipurpose use as food. Lack of suitable post harvest management practices may lead to a huge economic loss for the banana producing regions. Different postharvest management practices are in use to enhance its shelf life by delaying the ripening, reducing respiration rate, and controlling the disease causing organisms, during transport and storage. An integrated approach can ensure product safety and quality that reaches the consumer, residing far away from the production area. In this article different pre-storage treatments viz. pre-cooling, chemical and biological treatment for disinfection, modified atmospheric packaging, chemical treatment, irradiation, and coating for enhancement of shelf life is discussed in brief.

INTRODUCTION

Banana is one of the widely grown and consumed fruits due to their distinct aroma and taste, in all parts of the world. It is the staple food and economic life line for many countries. It is cheap source of carbohydrate and rich source of potassium, calcium, antioxidants and other micronutrients. The sugar rich and low-fat bananas have varied uses as infant food, functional food, dessert, carbohydrate based staple food and many more diversified food/feed uses. But this fruit is highly perishable owing to its high water content and is susceptible to many diseases, especially fungal infection. Being a climacteric fruit, it produces enough ethylene bringing about rapid changes in physico-chemical properties, such as colour, texture, aroma, chemical composition, respiration rate and senescence.

In many places, there is significant loss of the food value of banana due to improper post harvest management practices that causes huge economic loss. Post production losses of banana can be reduced by adopting various post-harvest management practices that are currently in practice all over the world to prolong its shelf life. Post harvest management practices such as cleaning, sorting, and pre-storage treatments, viz. pre-cooling, chemical treatment for disinfection, modified atmospheric packaging.

Harvesting

The harvesting standard varies from place to place, season, transport distance and the end use of the fruit. For local use, the fruits may be harvested at fully matured stage; for short distance transport, the fruits may be harvested at 90% maturity level and for long distance transport, the fruits may even be harvested at a maturity level of 75%. Again, the fruits are used for table purpose or processed for value addition. For processing, fully matured and yellow banana is preferred. In the later case, usually, green banana is used which has yet to reach the climacteric stage. In the cooler season, the fruits may be harvested after 105 days of flowering, but during hot season, the fruits can be harvested between 98 to 115 days. After harvest, bunches are properly cushioned and transported to the warehouse. Mechanical damage to bananas during transport results in crown browning caused by enzymatic oxidative degradation

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

of phenolic compounds by polyphenol oxidase. This can be avoided by dehanding the fruits under water, applying vacuum, waxing and application of antioxidants like thiourea and potassium aluminium sulphate.

Precooling

Field heat generated due to the harvest stress can cause overheating of the fruits. This may result in damage of the plant tissues and acceleration of the biochemical activities, causing spoilage. Several methods like hydro cooling, air-blast cooling, vacuum cooling and liquid carbon dioxide gas cooling have been in use, separately or in combination, to take care of this heat load from horticultural crops. Hydro cooling is achieved by dipping/drenching, rinsing/ immersing or spraying cold water over the bananas bunches for effective field heat removal. In air blast cooling method, banana bunches are subjected to a jet of cooled air for removal of field heat whereas in vacuum cooling the fruits are treated under vacuum for few minutes. The bananas are cleaned and disinfected properly before packaging to maintain quality during distribution.

Cleaning and disease control

The banana hands, cut out from the bunch, are washed in clean and flowing water, to remove the accumulated dirt and dust, as well as the latex that exudes from the cut surface of crown. Cleaning, delatexing and fungal control can also be done using hot water, which is quite effective in controlling the crown rot disease. The hot water temperature above 50ºC causes severe scalding and hence it is recommended that the bananas should be treated at 50ºC for 20 minutes for effective control of crown rot disease. Hot water treatment not only cleanses and disinfects but also prevents peel blackening of the bananas going for successive cold storage.

Chemical treatment

The fruit is susceptible to crown rot diseases caused by a fungus Fusarium aff. Sacchari. The crown rot disease can be effectively controlled by using chemicals extracted from citrus seed, in combination with the wax-based adjuvant and fungicides like thiabendazol, imazalil, ammonium sulphate, potassium sorbate, sodium benzoate, oxalic and maleic acids, cinnamon extract, piper extract, garlic extract, chlorine water and chitosan solution along with or without hot water treatment.

Fungicidal coating

Banana preservation has two phases i.e. an initial preservation period between harvesting and initiation of the ripening process and a second preservation period between initiation of the ripening process and the time of consumption. Some of the coating processes may be employed to banana for preservation in either or both of these periods. Polyvinylidene chloride copolymer along with surfactant and optional ingredients *i.e.* antimicrobials, plasticizers and antifoaming agents, can be effectively used as preripening and post ripening coating. The anthracnose infection can be inhibited by coating the bananas with organic acids like oleic, palmitic, lauric, malic, citric, oxalic, and maleic acids, incorporated in coating materials like chitosan, carboxymethyl cellulose and carboxymethyl chitosan. The coating creates partial anaerobic conditions, favouring greater production of metabolites like acetaldehyde and ethanol. This helps in quality improvement in coated bananas through astringency removal.

Coating

Various type coatings have been in the market is flooded with such packaged food materials. Some of the packaging materials are biodegradable, and some of them are composites. Some of the biodegradable as well as composite packaging materials are edible. For fresh whole banana fruits, edible coating will not be a suitable option as the banana is usually consumed after being peeled. In such cases both biodegradable and non biodegradable or composite films with distinct potential to delay the ripening and reduce the respiration rate as well as micro flora population, will be of utmost importance. Coating the fruit prior to ripening initiation delays the rapid ethylene production, thus delaying the ripening process and the chlorophyll loss which normally accompanies ripening. Modified atmospheric storage/controlled atmospheric storage/active packaging Storage techniques like controlled atmospheric storage and modified atmospheric packaging involves manipulation of respiration rate of the stored produce, by altering the CO_2:O_2 in the packaging system. For fruits and vegetables, a modified atmospheric packaging environment with 3-8% CO_2, 2-5% O_2 and 87-95% N_2 has been found suitable.

Irradiation

The ripening process in bananas can be effectively delayed by irradiation at lower dose (0.2 kGy with a dose rate of 7.35 kGy h”1) through retardation of softening and colour change. Irradiation decreases sensitivity of the banana to its own endogenous ethylene without causing any phytotoxicity. At the same time, it does not affect ripening using high concentrations of exogenous ethylene. However, a higher dose (0.4 -1.0 kGy) may cause discolouration, extensive tissue damage and change in respiration rate and reduced sensitivity to exogenous ethylene exposure. Though irradiation has been used for delaying the ripening process, its application in disinfection of banana can be explored, as it has already been proven worth for other fruits. UV-radiation can cause increase level of antioxidant activities of fresh cur bananas thus can help in reducing the microbial load, ensuring enhanced shelf-life.

CONCLUSION

The extent of post harvest losses of fresh fruits attributed to mishandling, improper storage practices and lack of modern transport facilities. This invariably leads to qualitative and quantitative losses. Minimization of these losses can safeguard the export potential and will aid to the revenue generation. With post harvest technological evolution and new practices replacing the older ones, it seems that the treatments for the extension of shelf life through microbial decontamination, insect disinfestations, and metabolic activity inhibiting methods can be applied alone or in coherent with each other to have synergistic effect on the spoilage caused in banana. Several niche technologies have been tried and tested successfully with other fruits and vegetables and are yet to be tried on banana for standardisation. This would immensely help the small as well as the large scale fresh banana retailers and related food processing industries, for further processing applications.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Public Private Partnership (PPP) in Agriculture: A step towards sustainable agricultural development

Article id: 22905

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INTRODUCTION

Agriculture is the main source of livelihood in developing countries. Two third populations of developing countries are dependent on agriculture for their bread directly or indirectly. About 54.6% of the population is engaged in agriculture and allied activities (census 2011) and it contributes 17.4% to the country's Gross Value Added for the year 2016-17 (at current prices). The Indian farmers are facing severe challenges of climate change, pest and diseases, irrigation, water, credit etc. The total cultivable land is shrinking, the grain area per person in India has shrunk steadily for several decades in 1950 it was 0.22 hectares. It is projected that in 2050 the figure will be as less as 0.06 hectares per person (Larsen, 2003). Problems in agricultural sector cannot be solved by a single actor alone but requires a system innovation. Production, processing and marketing in agriculture are dynamic in nature due to continuous change in consumer's demand and expectation. An innovative approach is essential to meet the current challenges of agriculture. (Ponnusamy,2013). For improving the condition of these people there is a need to develop the agriculture of these regions. Now a days Public Private Partnerships (PPP) in agricultural provide opportunities for conducting advanced research, developing new technologies, and deploying new products for the benefit of small-scale, resource-poor farmers and other marginalized social groups in developing countries (Anonymous, 2014).

PUBLIC PRIVATE PARTNERSHIP: MEANING AND CONCEPT

A public private partnership is a cooperative and collaborative arrangement between two or more public and private sectors, typically of a long-term nature (Hodge and Greve, 2007). A public-private partnership is a contractual agreement between a public agency (federal, state or local) and a private sector entity. Through this agreement, skills and assets of each sector (public and private) are shared in delivering a service or a facility for the use of the general public. In addition to the sharing of the resources, each party shares risks and rewards potential in the delivery of the service and/or the facility. The PPP approach supplements scarce public resources, creates a more competitive environment and helps to improve efficiencies and reduce costs. The rationale for public sector involvement differs between different kinds of services and influences the type of involvement required (Paul and Margaret,2003). Planning Commission of India has defined the PPP in a generic term as "a mode of implementing government programmes/schemes in partnership with the private sector. It provides an opportunity for private sector participation in financing, designing, construction, operation and maintenance of public sector programme and projects. Risk allocation plays a vital role in PPP management. Preplanned proposals with time

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

frame, budget, methods and materials would result in expected outcome of PPP, for which it is established.

NEED FOR PPP IN AGRICULTURE SECTOR

Agriculture GDP is heavily weighted in favour of high value produce (horticulture, animal husbandry, dairy, poultry and fish products); as much as 75 per cent of Agriculture GDP value today is contributed by these products (Shukla et al.,2016). It can be said that only way India can achieve a 4 per cent growth rate in agriculture is by laying greater emphasis on the allied sectors. India's expenditure on agricultural R&D and education is currently about 0.6 per cent of the GDP from agriculture and allied activities which needs to be raised at least to 1.0 per cent (Planning Commission 2011). It can be implemented in a number of areas like agricultural research, agricultural supply chain management, watershed management, agricultural extension management, Biotechnology, etc (Rai et al.,2017). Public Private Partnership is most preferred in developing countries for effective delivery of infrastructure facilities like transportation, education and health care services as it is more successful there. In developing countries, rural-urban migration has increased urbanization at same time socio-economic developments have increased the demand for infrastructure and also pressure on maintaining and operating the existing infrastructure. Thus private sector could be attracted through mutually beneficial agreement for efficient use of resources, availability of modern technology, better project design and implementation and improved operation combine to deliver efficiency.

BENEFITS OF PUBLIC PRIVATE PARTNERSHIP

Some of the benefits of public and private sector coming together are discussed below:

i) Respective strengths: PPP combines the best features of the public and private sector together. The private sector can leverage its advantages in creative financing, greater operational efficiency, lower costs of distribution, more complex delivery systems, faster decision-making, management flexibility and innovation. The public sector can provide strategic direction – the choice, location and pricing of infrastructure; ensure transparency in procurement and above all, through capital or user fee subsidies, or commitments to purchasing agreements, enable private firms to enter large markets with guaranteed consumers.

ii) Reduced up-front public capital investment and mobilization of private capital

iii)Bundling design, construction and operations: Rather than there being separate design, construction, financing, operations and maintenance arrangements, as with traditional public sector procurement of infrastructure, involvement of the private sector encourages these functions to be combined under one contractor.

iv)Cost savings: Efficiency can be higher in the private sector, with greater opportunities for economies of scale, strong project management skills, response risk management, more attuned skills, innovative technologies and lower overheads.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

v)Expanding reach to unaffordable projects: PPP arrangements also allow the public sector to consider otherwise unaffordable projects. PPPs thus allow the public sector to leverage more financial resources by using the private sector as an intermediary (Anonymous, 2011).

vi) More efficient implementation: Flexible subcontracting and procurement, quicker approvals for new capital financing, more efficient decision-making and stronger project management are some of the direct benefits of private sector participation in PPP models (Shukla et al.,2016).

MODELS OF PUBLIC PRIVATE PARTNERSHIP

PPP models describe the partnerships agreement between public and private sector. Some of the PPP Models relevant for agricultural infrastructure are discussed below:

Table 1: Models of public private partnership for agricultural infrastructure

Models	Role of private sector	Role of public sector	Examples
Build-operate-transfer (BOT)	Finances, builds and operates	Buys back or leases	Roads and highway sectors
Build-operate-own (BOO)	Finances, builds, owns and operates	Resource allocation	Water treatment plants of South Australia
Leasing	Design, building or operation but not financing	Risk transfer partly	In Sri Lanka, local governments rent municipal markets to private merchants.
Concessions	Awarded full responsibility	Service Provider to regulator	
Joint ventures	Jointly finance, own and operate a facility		Development Organisations
Operational/service management contracts	Managerial & technical assistance	finances	North bengal, Zopar service provider in Meghalaya
Informal public-private co-operation	Coordination among national & local govt., donors, organisations, agencies, civil society and NGOs		Social issues

(Shukla et al.,2016).

SOME EXAMPLES OF PPPs IN AGRI VALUE CHAIN

i) **PPP for crop diversification and contract farming**: The Punjab state government promoted Punjab Agro Foodgrains Corporation (PAFC) had an aggressive target of bringing a fourth of its acreage under non-grains. The Government has taken the support of private players through the contract farming route to achievements target. The government of the Punjab through PAFC reimbursed extension cost to the CF agencies/facilitators at the rate of Rs 150 per acre for three years, in order to facilitate contract farming with the aim of achieving crop diversification.

ii) **Creating producer bodies through PPP**: Another outstanding case of PPPs is the creation of Mahagrapes by the Maharashtra State Agricultural Marketing Board (MSAMB), the Department of Cooperation, Government of Maharashtra, the National Horticulture Board (NHB), the National Co-operative Development Corporation (NCDC), the Agricultural Products Export Development Authority (APEDA) and the grape growers themselves for the benefit of grape growers. The objective was to promote the marketing of grapes globally and to attend to the problems of quality and rejection in the global market faced by the growers' produce.

iii) **PPP for agricultural extension**: In Madhya Pradesh (MP), there was a PPP in agricultural extension involving the national institute of agricultural extension management (MANAGE) based in Hyderabad, the Department of Agriculture (DoA), the Government of MP and the Dhanuka Agritech Group, which markets plant protection chemicals including ecofriendly products. The partnership was intended to foster increased productivity on farms and improve the standards of living, of farmers, providing services,cyber dhabas (countryside/highway eateries in India serving local ethnic food), exhibitions and market linkages for agricultural produce (Singh,2011).

iv) PPP for organic production: In Uttarakhand, Kohinoor Food Ltd (KFL), one of India's leading companies in the organized marketing of rice including Basmati rice attempted a PPP in organic basmati rice. To increase its supplies, KFL tried to identify farmers for the organic programme and to this end with the help of Uttrakhand Organic Commodity Board (UOCB), a state government agency, KFL made contact with a Basmati farmers'federation in Dehradun district.

v) PPP for marketing infrastructure: Terminal markets is a public-private partnership model that links production centre to the consumption centre. The Government of India is looking to promote terminal markets in cities of Mumbai, Nashik, Nagpur, Chandigarh, Rai Patna, Bhopal and Kolkata as well as Ahmedabad and Surat in Gujarat. These markets will operate on a hub-spoke format, wherein the market (hub) would be linked to a number of collection centres (spokes), which in turn would be located at key production centres for convenience of farmers.

vi) PPP for agricultural services: For improving the condition and benefiting the tribal farmers, the government of Gujarat and Deere and Company (Global Leader in the field of agricultural equipment) are working together towards a Public Private Partnership model, which is first of its kind. Deere and Company opened small agricultural implement resource centers across Gujarat, making more than 500 tractors available for use by local farmers and providing the farmers access to use a set of 13 different implements for various operations. (Shukla *et al.,*2016).

CONCLUSIONS

PPPs could be a useful tool to accelerate development in various areas of agribusiness and infrastructure. Currently there are PPPs in the areas of contract farming, drip irrigation projects and terminal markets among others. However the scope of these projects is still limited and they serve as examples or models rather than be the norm.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Management practices in mango for quality improvement

Article id: 22906

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INTRODUCTION: Mango fruit quality is influenced by number of pre and post-harvest cultural and management practices. Fruit quality characteristics include firmness, ground colour, amount of red coloration, size, shape, sugar level, acid content, texture, freedom from defects and general appearance. Almost every cultural practice performed by a grower will influence one or more of these quality parameters. Therefore, the grower can have significant impact on the final quality of his fruit and an understanding of the effects of pre harvest and post-harvest practices on quality is important, particularly in relation to storage. Mechanisms for improving a number of quality parameters are relatively well understood (e.g. size, colour, eating quality and mainly involve general plant health, exposure to radiation (especially of the fruit itself), and appropriate leaf: fruit ratio. However, these treatments can affect other quality parameters. In particular, interactions with shelf and storage life are often more difficult to identify and yet can have significant influences in fruit marketing through transport and storage.

Factors Influencing Mango Fruit Quality

Many factors influence the composition and quality of mango fruits includes

1. Environmental
    a. Temperature
    b. Wind
    c. Rainfall
2. Thinning and pruning
3. Insect, pests and diseases
4. Plant growth regulators
5. Irrigation
6. Nutrition
7. Maturity at harvest
8. Harvesting operations

Factors may influence fruit quality by affecting the development and maturation processes of the fruit, physical effects on quality and pack out and by inducing susceptibility to physiological and pathological breakdown.

Cultural and Management factors influencing fruit quality

1) Bagging of fruits

Bagging of fruit for controlling the postharvest diseases and bruises with newspaper or brown bags one month prior to harvest should be done to get maximum fruit quality. The bagged fruits will ripe uniformly without any disease and fruit fly infestation. The problem of blackening and over ripening is overcome. The shelf-life of such fruits is also increased by two or three days. It also checks jelly seed formation (softening of pulp near stone). This technique is eco-friendly and job oriented. However, the bags are not suited for colour varieties.

2) Irrigation

Although the mango tree is considered to be drought-hardy, a good water supply is still important to ensure good growth and high quality fruit. Too much water can lead to waterlogging and root rot and too little can stress the tree and stunt growth.

The mango stem-end rot fungi are endophytic and grow into the fruit through the pedicel during fruit growth. Therefore, field treatment, (pruning and irrigation) which retard mycelia growth toward the fruit but not at the same time maintain or increase branch or pedicel growth, could reduce fruit colonization. So with holding irrigation during the last few weeks of maturation of mango increases total soluble solids (Crisosto *et al*., 1994).

3) Mineral nutrition

Once trees are bearing, the time of fertilizer applications is as important as the quantity applied. Vegetative growth should not be encouraged at the expense of flower and fruit production. Too much fertilizer at the wrong time can also affect fruit quality.

Of the nutrients, timing the nitrogen and potassium application is the most critical because high nitrogen is generally associated with maintenance of green colour in mango and potassium has been shown to have a consistent effect on flavour, through increased acidity. Most of the nitrogen and potassium needs are applied as soon as the harvesting is completed. Application of 1 kg Murate of potash or Sulphate of potash along with 2 kg urea and 6 kg Superphosphate during July-August in the basin and incorporation could rectify potassium deficiency. Calcium based nutrition is particularly important during early fruit growth and management practices should be particularly targeted to maximize calcium available to fruit during this period. High fruit calcium concentrations in mango retard green colour loss and softening during ripening.

4) Thinning and pruning

Thinning

Fruitlet thinning produces the well known response of increasing fruit size. It also reduces total yield so a balance between yield and fruit size must be achieved. Generally, maximum profit does not occur at maximum marketable yield since larger fruit bring a higher price in the market. A grower must rely on his own experience to determine the optimum thinning level for any given orchard and variety. Leaving too many fruit on a tree not only reduces fruit size but also decreases the soluble solid content of each individual fruit. Therefore, fruit quality can be sacrificed in several ways if thinning is not performed correctly (Yeshitela *et al*., 2003). Early reduction in the number of mango fruits on the tree, to a quantity the tree can bear up to harvest, greatly reduced further fruit drop.

Pruning

The greater the light interception by an individual fruit and surrounding leaves the better the quality of that fruit. Better light penetration also assists fruit colour development. Early pruning after harvest can also help to synchronize shoot growth to achieve more uniform flowering (Fivas and Grove, 1998). To develop a strong trunk the trees should be allowed to grow to over 1 meter in height initially then cut back to a height of between 0.6 to 0.7 m. First pruning should be done immediately after harvest while the second pruning should follow the floral rather than a vegetative flush appearance.

5) Rainfall

Rainfall immediately before harvest of mango has been consistently related to increased skin browning following bruising or hot water dipping for disease control.

6) Plant Growth Regulators

Plant growth regulators are defined as substances which are naturally produced in plants, control growth or other physiological functions, at a sight remote form its place of production and active in extreme minute quantities. By using 2,4,5-T fruit setting and yield can be increased. Similarly, IAA, IBA and NAA induced higher fruit set. Plant growth regulators affects on mango when sprayed well before maturity. Gebberellic acid (GA) decreases total soluble solids (TSS)/Acid ratio. Similarly, gibberellins sprays well before harvest also delayed ripening of mangoes.

7) Insect, Pest and Diseases

Proper identification and early interventions are essential for successful insect pest management. Regular monitoring, careful pesticides selection and good timing are the keys to good pest management with minimal adverse effects.

Major Mango Pests

Mango scale, fruit fly, mango hopper, fruit spotting bugs, mango seed weevil mango shoot caterpillar, mango tip borer, flower eating caterpillar.

Diseases

The approach to disease control is different to that for insect and mite pests. As disease organisms are microscopic, they cannot be seen and their arrival and build up in the crop cannot be as easily monitored. In most cases, disease control requires routine preventative spraying to protect the crop from possible infection. The major diseases controlled through spraying are anthracnose, stem-end rot, mango scab, bacterial black spot (which damage fruit and shoot) and powdery mildew (which affects flowers) (Johnson *et al*., 1992).

Insect, Pest and Disease Management

1. Bagging will provide shelter to the fruits and checks the development of postharvest diseases and fruit fly infestation.
2. If bagging has not been done, pretreatment of fruits is required for controlling postharvest diseases. Harvested fruits should be dipped in 0.025% Carbendazim in hot water (52±1°C) for 10 minutes.
3. Fixing of wooden block Methyl Eugenol traps @ 3-5 traps per hectare commencing

from first week of March to manage fruit fly (Mossler and Nesheim, 2003).
4. Three sprays per hectare of 2.0% Calcium chloride at 10 days interval prevent the jelly seed formation and it also delays the ripening.
5. Anthracnose can be controlled by weekly sprays of copper based fungicides from panicle appearance until fruit set.

8) Harvesting Practices

Harvesting practices have probably the most dramatic effects on fruit quality. As a fruit approaches maturity, many quality parameters are changing rapidly. Total soluble solid contents and percent red colour are increasing. However, fruit firmness is also decreasing at the same time with many newer varieties, fruit softening occurs at relative slow rate. Therefore, it is possible to leave these fruit on the tree for 3-5 days beyond minimum maturity in order to improve fruit quality and total yield.

Recognizing Maturity

The mango fruits should be harvested in a green mature stage so that it can be packed and delivered to market before it ripens and becomes too soft. To achieve good flavour and appearance, mangoes must be fully mature before harvesting. The harvest maturity in Dusehri and Langra cultivars reaches 12 weeks after fruit set, while in Chaunsa and Mallika it takes about 15 weeks. The best way to observe maturity in mango is the colour of the pulp which turns cream to yellow on maturity and hardening of the stone.

Harvesting

The harvesting in mango should be done in the morning hours and fruits should be collected in plastic trays and kept in shades. The fruits should not be allowed to fall on the ground as the injured fruits cause spoilage to other fruits during packaging and storage. Mangoes must be harvested and handled very carefully as the fruit is easily damaged during handling. Skin can also be damaged by rough handling and by contact with mango sap. Fruits harvested with 8-10 mm long stalk appear better on ripening as undesired spots on skin caused by sap burn are prevented. Such fruits are less prone to stem-end rot and other storage diseases.

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e-ISSN: 2581 - 8317
Volume 2 – Issue 2 – February 2020

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

SRI cultivation (More yield with less water)

Article id: 22907

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INTRODUCTION:

In SRI cultivation more yields can be obtained with less water and less cost of cultivation. It was first introduced in 1980 in Madagascar. Most of the farmers in China, Indonesia, Combodia, Thailand, Bangladesh, Srilanka and India are following SRI cultivation.

Seed rate: 2 kg/ac

SRI cultivation promotes natural growth of crop so crop grows very healthy. Roots spread sparsely and deeply and absorbs nutrients from deeper layers. In conventional method to uproot three hills it requires 28 kg strength but in SRI method to uproot one hill it requires 53 kg strength. In conventional method, plants use most of the energy for constructing air sacs but in SRI method that energy will be used for grin formation and development. In SRI method there should be no water stagnation in fields so 3/4th of water can be saved in this method.

Six principles of SRI:

1. **Planting of young aged seedlings:** 8-12 days old seedlings with two leaves should be transplanted so that plant can has profuse tillering and wide spread of roots.
2. **Careful transplantation:** Seedlings should be uprooted along with roots, mud and see and should be planted in top layers. Should not be planted deeply.
3. **Wider spacing**: 25 x 25 cm spacing should be followed in SRI method. In more fertile soils spacing can be increased.
4. **Weed management**: As there is no water stagnation, weed incidence will be more in SRI. Weeding should be done with rotary or cono weeder at 10 DAT and again three times with 10 days interval and mix in the soil. This will add 1 t green manure to the soil. Using rotary/cono weeder will increase oxygen supply to plants. It will increase microbial population in the soil and fixes atmospheric nitrogen. Weeding with rotary/cono weeder more than twice will increase yield @ 2 t/ha.
5. **Water management**: Water management should be done carefully. Field should be wet but not logged. Drainage channels should be prepared at every 2 m interval to drain excess water. Irrigation should be given if field dries so that roots will grow healthy.
6. **Organic manures:** Organic manures should be used to improve soil fertility. Chemical fertilizers are using during initial stages which should be reduced.

Planting of 8-10 days old seedlings improves and strengthens root growth and produce 30-50 tillers/plant. By following 6 principles of SRI each plant can produce 50-100 strong tillers which come to maturity at same time and increase yields. Each panicle has upto 400 seeds. Microbial population will be increased in SRI which supplies nutrients to plants naturally and also increases soil fertility.

SRI nursery management: 2 kg seed should be grown in 1 cent area for 1 acre rice field. Land should be ploughed, puddled and raised beds should be prepared with drainage channels around the beds. To prevent loss of wet soil beds should be supported with wood or any other material. After preparation of nursery beds, one layer well decomposed Farm Yard Manure should be spread on the beds. On the FYM, spread the sprouted seed (24 hrs soaked and 24 hrs sprouted). Again spread one layer of farm yard manure on the seed and then straw. After emergence, remove the straw. Sprinkle water everyday. Seedlings with 2-3 leaves will get ready within 8 days. Uproot the seedlings along with soil and seed and transplant in the main field at 25 x a5 cm spacing marked with marker.

SRI Main field preparation:

Main field preparation should be done as conventional method. Only difference is water should not be stagnated. Lines should be drawn with marker at 25 x 25 cm horizontally and vertically and seedlings should be planted at the joining point of lines. Drainage channels should be there at every 2 m interval.

CONCLUSION:

Following six principles and cultivation paddy through SRI method gives more yield with less water, less inputs and less cost of cultivation.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Nested Association Mapping: A Potent Tool for Dissecting Quantitative Traits

Article id: 22908

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Nested Association Mapping (NAM) is a QTL mapping technique designed to identify and dissect the genetic architecture of complex, quantitative traits. Primarily it was designed for maize (*Zea mays*) improvement by Edward Buckler, James Holland and Michael McMullen in 2008. The method is called 'Nested' because the individuals of the mapping population have one parent in common but each population has another different alternate parent.

Why do we need nested association mapping?

Before the invention of this novel technique, QTL analysis was mainly based on linkage analysis in a mapping population (structured population) developed from a bi-parental cross. The other approach was association mapping, where the entire germplasm collection (unstructured population) is taken as a mapping population. Both of these two methods had specific disadvantages. For example, the bi-parental mapping of QTL based on a linkage map of a F_2 population, which is resultant of a single meiotic cycle or one cross-over generation. As a result, both the mapping resolution as well as allele richness is low. Association mapping or linkage disequilibrium mapping, in contrast, takes advantage of historic recombination (uncountable meiotic cycles during the evolution of the species and the individual accession). Although this technique results in high precision and resolution in trait mapping and has high allele richness, it requires extensive knowledge about the marker distribution across the genome. NAM takes the advantage of both historic and recent recombination (during the production of specific mapping population) events to have the advantages low marker density requirements, high allele richness, high mapping resolution and high statistical power, with none of the disadvantages of either linkage or association mapping. Hence, NAM is the need of the hour as advanced mapping strategy in different crops.

Development of a specific population for nested association mapping:

The most frequently used population for NAM population. Here, structured families are nested within an unstructured population (germplasm lines). NAM population is developed by crossing many diverse parental inbred or germplasm (as testers) with a single reference line (founder) line. The resulting F_{1s} are then forwarded to F_6 or F_7 generation by following single seed-descent method. Thus the resultant immortal Recombinant Inbred Line (RIL) population serves as Nested Association Mapping (NAM) population. The selection of the parents depends upon the target trait and the selected tester lines should be distinctly different from each other and carry different locus concerning to the trait under study. On the other hand, the reference (founder) line is generally a reference variety of the particular crop. Care has to be taken to maintain the pedigree record in each generation and to avoid any cross-contamination of pollens while self-pollination of the individual plants.

Process of nested association mapping:

Nested association mapping is mainly performed based on the single nucleotide polymorphisms in the members of the NAM populations through Genome-Wide Association Studies of the SNPs and the phenotypic data using suitable software [TASSEL-Trait Analysis by aSSociation, Evolution and Linkage] to identify the locus tightly linked with the phenotype under study.

Advantages nested association mapping:

1. Simultaneous mapping of more than one quantitative trait at a time by taking the target traits in the different parental lines and developing such NAM population.
2. Identification of minor QTL (<10% contribution on the trait) is possible by this method. If the contribution of the QTL is not found in one population due to the presence of epistasis, the effect might be found in another population.
3. High mapping resolution and allele richness are obtained here as it takes into account both the historical and recent crossing over.

Recent applications of nested association mapping in crop improvement:

- For the first time, this technique was employed by Buckler et al. (2009) to map QTL governing flowering-time related traits (days to silking and days to anthesis). They reported an allele with miniature transposon associated with early flowering and another allele with SNPs associated with late-flowering.
- Poland et al. (2011) identified 29 QTL governing resistance to northern leaf blight in maize using NAM technique. Majority of the QTL had multiple alleles and additive gene action prevailed.
- Pascual *et al.* (2015) dissected the genetic architecture of the trait fruit weight in tomato employing this technique in an eight-parent MAGIC population.
- Salari (2015) employed NAM and identified two QTL one each on chromosome 1 and chromosome 3 explaining 10% and 22% phenotypic variation for seed sucrose content in soybean.
- Using this technique, Bajgain et al. (2016) identified a total of 59 QTL with minor to moderate effects governing resistance to stem rust in wheat.
- Li et al. (2016) identified a total of 21 QTL governing resistance to plant height and ear height in maize nested association mapping populations.
- Saade et al. (2016) identified yield-related salinity tolerant genes on chromosome 2H in a nested association mapping in barley.
- Nice et al. (2017) identified QTL governing the number of days to heading, plant height and the non-brittle (Btr1/Btr2) loci for test weight and yield in barley.
- Ren et al. (2017) employed QTL analysis and nested association mapping for adult plant resistance to powdery mildew in two bread-wheat populations and identified two common and significant QTL governing the resistance.

- Hu et al. (2018) constructed a *Brassica napus* (*BN*-NAM) population involving semi-winter and spring oilseed rapes.

Disadvantages of nested association mapping:

The major and probably, the only disadvantage of this method is that the development of the mapping population is difficult and takes much time and resources. Moreover, this technique cannot be employed in populations other than the NAM populations. This technique is not suitable for crops with very high inbreeding depression. Examples: onion and carrot.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Effect of Global warming on Agriculture

Article id: 22909

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Earth's atmosphere is mainly composed of nitrogen (N) and oxygen (O_2), but these gases have little or no influence on radiation coming from the sun or that emitted by Earth's surface. The so-called greenhouse gases (GHGs), which include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and chlorofluorocarbons (CFCs), however, absorb and reemit infrared radiation emitted by the surface of the Earth and trap heat in the atmosphere. This amplified warming keeps Earth's surface warmer (about 33 ˚C) than it would be without the presence of GHGs (National Research Council, United States, 2010). Global warming results from the increase in greenhouse effect in the atmosphere. It is a blanket of gases, which wraps around the Earth and holds the heat in. CO_2 is the most common gas that causes global warming. The more the global temperature increases, the more the climate changes. Human and industrial activities are mainly responsible for the rise in the concentration of GHGs in the atmosphere. CO_2, the most abundant GHG, is mainly increasing because of fossil fuel combustion. Similarly, industrial processes cause CFC emissions. The increased agricultural activities and organic waste management are contributing to the buildup of CH_4 and N_2O in the atmosphere (Hundal and Abrol, 1991). The global mean annual temperature at the end of the twentieth century was almost 0.7 ˚C above that recorded at the end of the nineteenth century and it is likely to increase further by 1.8-6.4 ˚C by AD 2100, with a best estimate of 1.8-4.0 ˚C (IPCC, 2007). The decade 1990-2000 was the warmest in the last 300 years and was 0.5 ˚C warmer than the mean temperature of 196-1990.

Global Warming effect: There are several direct and indirect effect of global warming and these are warmer summers have included record hot spells and high sunshine hours, and the warm winters have reduced the number of frosts. The quantity of rainfall and its distribution are also greatly affected by climate change and these are expected to increase the problems of flooding and soil erosion. Moreover, the sea level has risen and snow cover is also gradually decreasing due to glacier meltdown, especially near the poles, and arable land is decreasing near coastal regions due to inundation. Agriculture, forest clearing and certain industrial activities also made significant contributions to climate change. A report of the IPCC during 2001 projected that the global mean temperature above Earth's surface would raise 1.4-5.8 ˚C during the next 100 years (IPCC, 2001).

Effect on Agriculture: Agriculture is the backbone of Indian economy, which in turn relies on the monsoon season. Rising global temperature is not only causing climate change but also contributing to the irregular rainfall patterns. Uneven rainfall patterns, increased temperature, elevated CO_2 content in the atmosphere are important climatic parameters, which affects the crop production. This can happen as temperature can reduce crop duration; increase crop respiration rates; alter photosynthate movement from source to sink; affect the survival and distribution of pest populations, thus developing a new equilibrium between crops and pests; hasten nutrient mineralization in soils; decrease fertilizer-use efficiencies; and increase evaporation (Kumar et al., 2011). The combined effects of climate change may have implications for dryland and irrigated crop yields. However, the effect on production is expected to vary by crop and location and by the magnitude of warming and the direction and magnitude of precipitation change.

Effect of elevated concentrations of CO_2 on crop growth: The direct effects of increased concentrations of CO_2 are normally beneficial to vegetation, especially for C_3 plants, as elevated concentrations enhance assimilation rates and increase stomatal resistance, which result in a decline in transpiration and improved water-use efficiency in crops. In northwestern India, for example, yields of rice and wheat increased by 15% and 28%, respectively, at elevated (doubled) CO_2 concentrations (Lal et al., 1998).

Effect of ozone on plants: Ozone is likely to have adverse effects on plant growth. Necrotrophic Pathogens (are bacterial, fungal and oomycete species that have very destructive pathogenesis strategies resulting in extensive necrosis, tissue maceration, and plant rots) can colonize plants that are weakened by O_3 at an accelerated rate, while obligate biotroph (which extract nutrients only from living plant tissues and cannot grow apart from their hosts) infections might be reduced (Manning, 1995).

Effect of increasing temperature on crop growth: Increases in temperature increase crop-respiration rates; reduce crop duration, the number of grains formed, and crop yield; inhibit sucrose assimilation in grains; affect the survival and distribution of pest populations; hasten nutrient mineralization in soil; decrease fertilizer-use efficiency; and increase evaporation. The reduction in wheat yield with an increase in maximum temperature was mainly attributable to a reduction in the duration of anthesis and in grain filling with a rise in ambient temperature. A team of experts from the Food and Agriculture Organization (FAO) concluded that each 1˚C rise in mean temperature would cause annual wheat (Triticum aestivum *L.*) yield losses in India of about 6 million tons.

CONCLUSION: Elevated CO_2 concentration may increase crop growth and yield due to increased photosynthesis, decreased photorespiration, and decreased stomatal conductance. The increase in temperature, however, may decrease grain yields of rice and wheat due to the shorter duration of crop growth. The protein content of legume grains may decrease with increased CO_2 concentration. Elevated CO_2 concentration may increase the availability of soil N and P because of increased mineralization and activity of phosphatase enzyme in the rhizosphere.

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DRAGON FRUIT: A potential exotic fruit crop

Article id: 22910

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Dragon fruit recently introduced super exotic fruit in the Indian market. It is getting tremendous popularity among growers because of its attractive fruit color and attractive look of pulp with edible black seed imbedded inside the pulp, nutraceutical value, excellent export potential and highly remunerative in nature as produces yield from 10- 16 months after planting of stem cutting and yield up to 20 years with long crop cycle from May – December in different flushes in every year.

INTRODUCTION

The Dragon Fruit is named as pitaya because of the bracts or scales on the fruit skin It is a climbing vine cactus species with the most beautiful fruit in the family Cactaceae that has beautiful flowers and is also called as 'Noblewoman' or 'Queen of the Night'.

The two major species growing under Indian conditions are *Hylocereus costaricensis*, red-fleshed pitaya and *Hylocereus undatus*, a white-fleshed pitaya. *Hylocereus* comprises 16 species, which are endemic to Latin America. The fruit comes in three types, all with leathery, slightly leafy skin: *Hylocereus undatus*— white flesh with pink skin, *Hylocereus polyrhizus*– red flesh with pink skin, *Hylocereus costaricencis* – with violet-red flesh and pink skin and *Hylocereus (Selenicerus) megalanthus* – white flesh with yellow skin.

Site Selection: Pitaya plants should be planted in an open well-light sunny area for best growth and fruit production.

Soil: Pitaya can be grown in a wide range of soils. Soils that are well-drained and high in organic matter are recommended.

Propagation: Healthy mature stem segments of 6 - 15 inches are used. A slanted cut is made at the stem base, this is left in a shaded area for about 5-7 days to dry and heal before being planted out directly in the field.

Spacing: Plants are spaced: With the concrete posts - 8ft X 10ft , With fence or wall - 4ft X 4ft. The distance between plants depends on the type of support used. With vertical support, a 2–3 m distance between planting lines is required which could accommodate 2000 and 3750 cuttings/ ha, at the rate of three cuttings per support is planted (N'Guyen, 1996 and Barbeau, 1990). Planting at a distance of 2.5 m each to row and between the plants, with 4 cutting/ support can accommodate 6400 plants/ha and also gives good yields and quality of fruits (Anon, 2017)

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Support structures: Dragon fruit is a semi epiphytic vine plant that can climb naturally to any natural or artificial support they meet (trees, wood or cement posts, stone walls, etc.) due to the presence of aerial roots. The concrete poles as trellises for the durability of the plant as the life of the vines are as long as 20 years. The concrete pillars are supported by a square structure in the top to train the vine for bearing purpose.

An alternative to concrete poles cost-effective structures like iron poles and tyres are used as a base structure. The structures are made at a spacing of 3 m ×3 m. The rooted cuttings of dragon fruit accessions were planted of 4 cuttings around each concrete pillar. The growth of dragon fruit vines was so fast that an average growth rate of 8.2 cm was observed per week. Weed control is an important operation in dragon fruit cultivation and the use of weed mat efficiently reduced the growth of the weeds and also aids in soil moisture conservation.

Fertilizer application: N 450, P2O5 350, K2O 300 perform the best result for yield and quality. The nutrients were supplied as per treatment schedule in four split doses to each pillar having four plants @ 10, 10 and 30% of total, before flowering, 20, 40 and 25% at fruit set, 30, 20 and 30% at harvest and finally 40, 30 and 15 % of total N P2O5 K2O after two months of harvest

Irrigation: Pitaya belongs to the Cactus family and tolerates dry conditions. A dry period is necessary for the plant to flower, however as the fruit matures, water is needed to increase the fruit set and fruit weight.

Weeding: Weeds close to the plant should be removed manually. Use a herbicide with a shield for weeds along with the inter-row space. Weed control is an important operation in dragon fruit cultivation and the use of weed mat efficiently reduced the growth of the weeds and also aids in soil moisture conservation.

Training: The main stem has to be trained for it to be able to use the support structure. Tie the stem to the support structure as it grows. Once this stem reaches the top of the support, cut the tips to induce branching and tie again to the support.

Pruning: Pruning may induce flowering and stem branching. Pruning is done to remove all damaged, diseased or dead stem and any stem that touches the soil. Pruning is also done after harvesting is completed or it can be done 1 - 3 times per year.

In about 8 months after planting the dragon fruit forms a thick dense mass of vines on top of the trellis which lies dropping to the ground.

Flowering: The flowering was initiated in the red-fleshed and white-fleshed dragon fruits in the month of nine months after planting. Dragon fruits become ready for harvesting in 25-35 days after flowering. The maturity index of the fruit is color breaking stage from a bright green color to red color.

Pollination: Manual pollination is simple and this operation is facilitated by the floral characteristics of Hylocereus, as the different floral parts are huge. A butterfly belonging to the

Sphingidae family, of the genus Maduca (Daubresse Balayer, 1999 and early morning by bees (Anon, 2017).

Harvesting: The exact time of harvesting is 3 to 4 days after color change for the local market. But in the case of long-distance transport/export, the fruits are to be harvested when the color break is noticed. The initial establishment cost is little high in the dragon fruit especially for the construction of trellis but once the plants are established, the fruits can be harvested continuously up to 20 years.

Marketing: The fruit has good demand in local as well as international markets. The fruits are marketed presently at the rate of Rs 200 to 250 / kg. It is a fast return potential fruit crop with production in the second year of planting. The present harvesting technique of simply move the fruit in clockwise direction and twisting the fruit cause less or no injury to the fruits.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Floriculture: A boost to Indian tourism Industry

Article id: 22911

Ritu Jain, Babita Singh, Prativa Anand and Vanlalruati

The tourism industry has emerged as one of the key drivers of growth among the services sector in India. The tourism industry in India is substantial and vibrant having significant potential for considering the rich cultural and historical heritage, variety in ecology, terrains and places of natural beauty spread across the country. Tourism is also a potentially large employment generator besides being a significant source of foreign exchange for the country. During 2018, Foreign exchange earnings from tourism increased 4.70 per cent* (US$ 28.59 billion). Foreign tourist arrivals in India, during 2018, stood at 10.56 million, achieving a growth rate of 5.20 per cent. In January 2019, FTA stood at 1.10 million, up 5.30 per cent compared to 1.05 million year-on-year (https://www.ibef.org/industry/tourism-hospitality-india.aspx). The hotel industry comprises a major part of tourism industry which provides employment to many people. International hotel chains are increasing their presence in the country, which will account for around 47 per cent share in the Tourism & Hospitality sector of India by 2020 and 50 per cent by 2022. According to the Department for Promotion of Industry and Internal Trade (2019), the hotel and tourism sector attracted around US$ 12 billion of FDI, from April 2000-December 2018.

Majority of the hotels at tourist destinations have motto to make guest feel better, happier and more comfortable and we all know that flowers are the best gift nature which provide immense pleasure, help us to remain happy, as these are nutrition to our soul. It is well known fact that the flowers are the gesture of welcome whether they are used in the main entrance in the form of flower string or as garland, as centerpiece of table, as arrangement, as vertical garden or lawns, topiary, bonsai etc.

Flowers are integral part of offerings, floral gifts and interior decoration; which give aesthetic appeal to the ambiance. As soon as tourist reaches to the hotel patio, or reception number of pot plants are there to reflect the variety or colours available. The pot plants are also used in corridors and rooms also. Apart from aesthetic appeal these plants helps in improving environment as these are natural scrubbers for many harmful gases produced by the use of many modern electronic gadgets like computer, laptops, mobiles, etc. The pot plants can be raised by the hotels or these can be taken on rent from commercial nurseries. These days pot plant rental is a big business, which provides employment number of people in a big way.

In five star hotels at reception point, visitor are welcomed with garlands or sometimes with a single cut flower to depict our tradition of welcoming guest with flowers, which is boost to the flower industry. In countries like Singapore, Thailand and Srilanka people are welcomed with garlands made up of orchid and plumeria.

In certain hotels and resorts where space is a limiting factor, there vertical gardening or garden in window boxes and use of hanging basket is a better provision for eco tourism. In vertical gardening the flowers or ornamental plants which have low maintenance can be used. Even to cover the parking areas roof gardens or window garden is a key feature.

For interior decoration purpose, different arrangements of flower placed on different places. The flower usage in hotel interior depends on the degree of luxury provided, as large spectacular arrangement are kept in the lobby, restaurant and small arrangement are kept in rooms or suites. These arrangements can be circular shape, triangular, Hagorth S shape, oval, cresent shape and fan shape. Besides use of major cut flowerslike roses, carnation, gerbera, chrysanthemum etc., the interior decoration in hotels is done with speciality flowers like heliconias, Bird of Paradise, ornamental curcumas, ornamental ginger, Tulips, Liliums, Lisianthus etc. besides decoration, these flower arrangements can be included in co curricular activity of house keeping in hotel management.

In every hotel a centerpiece is placed on the table, which is made up of fresh flowers or dry flower. If someone is planning for candle light dinner, then aromatic candles can be used to make the place comfortable and pleasing for the tourist as the use of aromatic candles will be special attraction to keep them in touch with nature.

These days many of the resorts and hotels at tourist places have provision for modern facilities like spa. Spa is a commercial establishment, providing facilities devoted especially to health, fitness, weight loss, beauty and relaxation. In these spas aromatherapy is done to provide beauty and mind relaxation using essential oils which are totally dependent on flowers as these are extracted from flowers like rose, jasmine, tuberose, etc. In these spas massage is given with the use of essential oils, as well as in hot springs also use of flower and flower petal is must. Even the flowers are used to produce many cosmetics which are used in these spas to rejuvenate the skin and face.

Hotels also organizes events like flower arrangement like ikebanas where number of flowers and other ornamental plant parts are used.

For functions like wedding or engagements etc. there is enormous use of major cut flower, minor flowers, Specialty flowers and fillers. Here the guests are welcomed by using many flower products like garland or bouquets or by sprinkling perfume or rose water.

For certain occasion in hotels, like global or international conference and workshops, tropical flowers like specialty flowers (Red Ginger, Anthuriums, Bird of Paradise, Heliconia, Tulips *etc.)* are used.

In certain five star hotels there is a provision of duty free shops, from where the foreign visitors can buy ethnic floral jewelry made up of flowers like orchids, flower seeds like canon shot, abracus, vaijanti mala etc.

The outdoor public area of hotels use number of shrubs, climbers and turf grass species to please their guests and keep the environment of surroundings healthy. All these trees, shrubs, climbers and turf grasses are major component of floriculture and landscaping.

In this way if the floriculture industry will keep the pace with hotel industry, definitely we can conserve our environment, can keep our surroundings neat and can live healthy life and the most important thing is that the hotel industry can satisfy their tourist which in turn will be the boost for the tourism industry.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Blockchain Technology: An Improvement in Agriculture

Article id: 22912

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Blockchain technology is gaining popularity with the rise of crypto currencies such as bitcoin. This century now become an era of artificial intelligence where we are moving towards digitizing. In this, crypto currencies are under blockchain techonology. Even though the first use of blockchain was in crypto currencies, its application to other transactions holds great potential. One of the areas where blockchain can be applied is in agriculture. Within the agricultural sector and its related products, blockchain technology can be sued to promote food safety, prevent food fraud and verify the origins and authenticity of agricultural products and agricultural inputs. All these are made possible because blockchain improves traceability and transparency.

Working system of Blockchain: The blockchain is based on a shared ledger or DLT (Distributed Ledger Technology). In more simple words—it is "one big ledger in the cloud." This ledger contains records, transaction details and information called blocks. These blocks are immutable and tamper-proof, *i.e.* the data in these blocks are hard to alter or hack. These blocks hold incorruptible trust. Anyone can put anything of value on blockchain from golds to tomatoes. All these features make it possible for the various network (like farmers, consumers, retailers) to register and share information with maximum safety, transparency and speed. In simpler terms think of blockchain as google sheets versus excel sheet sent through emails. In google sheets, all members have live access to the data being entered into the sheets and can independently record/track the updates of every entry being made. Add another layer on top of this, where entry once made is recorded permanently and cannot be edited or erased by any member. What makes blockchain so unique is that data stored on its networks is transparent and incorruptible. Data is embedded on the network as a whole, by definition it is public and data once stored cannot be corrupted by altering any information on the blockchain. The data entered is visible to all of the elements in the blockchain. One has the freedom to approve or reject the information. Once the data is validated, it gets recorded into blocks, which gets organized in a chronological chain which cannot be altered by anyone. With blockchain technology, we can put all the information about the entire cycle of agricultural events onto blockchain to enable transparent and trusted source of information for the farmers. Farmers can get instant data related to the seed quality, soil moisture, climate & environment related data, payments, demand and sale price, etc. all at one platform. Blockchain will help in establishing direct link between farmers and consumers/retailers.

Use of Blockchain in Agriculture:

Food safety: Blockchain technology can be used to ensure food safety within the agricultural supply chain. The Food and Agriculture Organization (FAO) defines food security as the situation when "*all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life*". Food safety is the condition of processing, managing and storing food in hygienic ways, in order to prevent illnesses from occurring to human population. The ability to trace the origin of food products becomes valuable in case of food safety outbreak. Industry regulators will be able to quickly pinpoint the source of the contaminant as well as determine the scope of the affected products. The early identification of the source of contamination will enable food companies to swing into action quickly to prevent illness and thus save lives. Such a timely response will also help limit food wastage and will save money by containing financial fallout.

Food supply chains: Agriculture and food supply chains are well interlinked, since the products of agriculture almost always are used as inputs in some multi-actor distributed supply chain, where the consumer is usually the final client (Maslova, 2017). The food chain worldwide is highly multi-actor based and distributed, with numerous different actors involved, such as farmers, shipping companies, distributors, and groceries. This system is currently inefficient and unreliable. For example, when people buy goods locally, they are not aware of the origins of these goods, or the environmental footprint of production. Various initiatives have been identified, where blockchain technology could be used to solve real-life practical problems at the agricultural supply chain.

Potential Benefits: Blockchain technology offers many benefits, as it can provide a secure, distributed way to perform transactions among different untrusted parties. This is a key element in agriculture and food supply chains, where numerous actors are involved from the raw production to the supermarket shelf. Blockchain has the potential to monitor social and environmental responsibility, improve provenance information, facilitate mobile payments, credits and financing, decrease transaction fees, and facilitate real-time management of supply chain transactions in a secure and trustworthy way.

Looking to the forward: In respect to education, there is a general lack of awareness about the blockchain, and training platforms are inexistent. Before adopting blockchain, farmers need to effectively understanding it. As farmers globally tend to dedicate their efforts in farming, they usually do not have expertise in cutting edge technologies. A lack of (common) understanding among policy makers and technical experts still exists on how blockchain technology and transactions based on some currency should be used. Although blockchain offers advanced security, there are high risks related to loss of funds, just because the account owner might have lost accidentally the private keys needed to access and manage the account. Finally, there seems to be a gap among the developed and developing world, in respect to digital competence and access to the blockchain technology.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

SMALL RNA: A master regulator in plant defense

Article id: 22913

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INTRODUCTION

A potent immune system is necessary for plants to survive pathogen infections; it also deprives the limited resources available for plant growth and development. Thus, plant immune responses must be tightly regulated. One strategy is to generate endogenous sRNAs that silence specific genes involved in plant hormone production or antimicrobial activity. Upon infection, the biogenesis or the accumulation of these sRNAs is regulated, which subsequently fine-tune plant hormone levels and the expression of genes involved in plant resistance.

Small RNAs

Small RNAs (sRNAs) are 20–30 nucleotide (nt) long non-coding RNA molecules, which are widely present in eukaryotic organisms. It is well established that sRNAs are involved in the regulation of gene expression through a process generally termed RNA silencing (Lopez *et al.,* 2012). RNA silencing contributes to almost all eukaryotic cellular processes, including preventing the invasion of viruses or transgenes, inhibiting the movement of transposable elements, and regulating developmental and physiological processes.

Types of sRNA

Plant sRNAs are divided into two major classes: microRNAs (miRNAs) and small interfering RNAs (siRNAs). Most miRNAs are 21–24 nt in length and derived from RNAs with imperfectly base-paired hairpin structures, while siRNAs are generated from perfectly complementary long dsRNAs. Plant siRNAs are grouped into four subclasses: *trans*-acting siRNAs (ta-siRNAs), heterochromatic siRNAs (hc-siRNAs), natural antisense transcript-derived siRNAs (nat-siRNAs), and long siRNAs (lsiRNAs). Proteins, such as Dicer-like proteins (DCLs), HYPONASTIC LEAVES 1 (HYL1), HUA ENHANCER 1 (HEN1), and Serrate (SE) are involved in sRNA biogenesis pathways. Bacteria, fungi and oomycetes infect plants without direct genome and RNA interaction with the host RNA silencing machineries.

Most common miRNA

miR393 - regulates at least three pathways to counteract pathogen infection.

- First, miR393 modulates 'SA-auxin' balance in disease resistance. SA primarily mediates defense against biotrophic pathogens, whereas auxin antagonizes SA function. Overexpression of AFB1 significantly reduces the SA level induced by Pto DC3000. Moreover, the DC3000 strain (COR_), defective in producing coronatine, is more virulent on plants overexpressing AFB1, and this phenotype mimics that of Yucca, a mutant over-accumulating auxin. In response to PAMP, miR393 is induced to tilt the hormonal balance toward a robust SA signaling.

- Second, miR393 promotes disease resistance by re-directing secondary metabolic flow. ARF1 and ARF9 are two transcription factors that activate downstream genes upon auxin perception. ARF1 and ARF9 promote the biogenesis of camalexin, an indolic phytoalexin that is mostly effective against necrotrophic fungi such as *Alternaria brassicicola* and inhibit the accumulation of glucosinolates, which are toxic to a wide range of bacteria.
- Third, miR393b, derived from the MIR393b transcripts, modulates the exocytosis of PR1, SA-induced antimicrobial protein (Huang *et al.,* 2016).

Roles of miRNA:

1. Inhibitor of Auxin pathway

Auxin is a plant hormone mainly implicated in growth, which acts under particular conditions, as a repressor of salicylic acid (SA). SA is a hormone involved in the activation of plant defenses in response to biotrophic pathogens. The best-studied miRNA induced upon bacterial infection is miR393. By comparing the gene expression profile of wild type and transgenic plants, it was demonstrated that upon treatment with flagellin (flg22), some transcripts were more abundant in transgenic plants (particularly, transcript coding for the F-box auxin receptor TIR1). By RACE (rapid amplification of cDNA ends) the authors demonstrated that this particular mRNA is targeted and cleaved by miR393.

The perception of flagellin by plants induced the expression of miR393 which correlates with a clear reduction of the TIR1 protein content. This led in turn to the stabilization of Aux/IAA proteins which repress auxin signaling by heterodimerization with Auxin Response Factors (ARF). Flagellin perception leads to a repression of auxin signaling and consequently restricted the growth *of Pseudomonas syringae* pv. tomato (*Pst*). So, there is a clear cut link between auxin response, miRNAs and MTI. In summary, plant represses the auxin signaling pathway in response to bacterial hit, favoring the defenses activated by SA, compromising vegetative growth.

Stage of expression

miR393 was shown to be induced in Arabidopsis plants inoculated with *Pst* DC3000 strain mutated in *hrcC*. This strain is defective for type III secretion, unable to deliver effector proteins into the host plant cell and consequently triggers MTI. Employing a small-RNA profiling analysis, the differential expression of miRNAs in plants challenged with *Pst* DC3000 *hrcC* mutant, a virulent strain of the same species carrying an empty vector and avirulent *Pst* DC3000 containing the *avrRpt2* effector. miR393 was repressed at 6 hours post-infection (hpi) and induced at 14 hpi in the three treatments (Yang and Huang, 2014).

2. Callose deposition

Transgenic plants over-expressing miR160 show enhanced callose deposition and higher resistance to DC3000 indicating a role for miR160 as positive regulator of plant pathogen response (Yang and Huang, 2014).

3. ROS production and cell wall biosynthesis

The predicted target of miR5229a/b is a transcript encoding for a heme peroxidase playing different roles in the regulation of ROS production, cell wall biosynthesis but also auxin and ethylene metabolism (Yang and Huang, 2014).

4. **MTI and silencing**

One of the identified miRNAs is miR825, which is predicted to target transcripts encoding a Remorin, a transcription factor of the zinc-finger homeobox family and a frataxin-related protein. These targets are known to act as positive regulators of plant defense, it is therefore expected that the miRNAs controlling them are repressed. A first connection between miRNAs-mediated silencing and MTI emerged from the study of Arabidopsis AGO1 mutant lines, found to be compromised in MTI. These plants are characterized by a reduction in seedling growth inhibition, callose deposition, expression of MTI-markers genes and the activation of MAP kinases and ROS production upon treatment with flagellin.

During bacterial infection, the conserved N- terminal part of flagellin, flg22, is recognized by a surface localized pattern recognition receptor FLS2. Perception of flg22 activates MTI and rapidly induces the accumulation of miR393, partly through activating the transcription of the MIR393 gene. In Arabidopsis, miR393 targets at least three F-box proteins (AFB), TIR1, AFB2, and AFB3, which are receptors of the plant hormone auxin. In the presence of auxin, AFBs directs the degradation of the aux/IAA protein, and derepresses the Auxin response factor (ARF) transcription factors to activate auxin response genes. Plants constitutively expressing MIR393a are less susceptible to the bacterial pathogen Pto DC3000, whereas AFB1 overexpressing plants support rapid Pto DC3000 growth (Yang and Huang, 2014).

5. ETI and miRNA

The involvement of miRNAs in regulating plant immunity is not restricted to MTI. It may also be associated to ETI. Nucleotide binding site, leucine rich repeat proteins are key sensors and regulators in ETI. Accumulating evidence has pointed to a role of small RNAs in regulating NBS-LRR proteins. Rapid advancements in genomic research have resulted in the identification of microRNA targeted NBS-LRR genes in a number of plant species, including grapevine, cotton, sugarcane, pine and citrus. natsiRNA (natsiRNAATGB2) acts as a positive regulator in avrRpt2 triggered ETI (Yang and Huang, 2014).

SUMMARY

Small RNAs, including miRNA, tasiRNA (phasiRNA), lsiRNA, and natsiRNA, play essential roles in the plant immune system. Some of these are specifically required for PTI, while others may function in ETI and in maintaining hormonal balance. The dual roles of these miRNAs in controlling defense and development provide us a novel angle to investigate the tradeoff between defense and growth. Modification of host small RNA pathways by pathogen delivered molecules and it creates battle between host and pathogen.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Red rice: Sacred and radical scavenger

Article id: 22914

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INTRODUCTION:

In Asian countries, where rice (Oryza sativa) is the staple food of more than two-thirds of the Population. Colored rice have been preferred in the past for their special features such as medicinal value and exclusive taste. Flavored, black rice were the favorites of the royals of China, while red rice were preferred by people in many parts of India, Sri Lanka, and Bhutan. Red rice is colored red by its anthocyanin content. It is usually eaten unhulled or partially hulled and has a red husk, rather than the more common brown. It has a nutty flavor. Compared to polished rice, it has the highest nutritional value. Red rice, also known as weedy rice, a low-yielding rice variety that persists as a weed in fields and also a major contaminant that reduces the market value of the end product.

Origin:

The origin of colored rice is as old as rice itself. According to a Japanese myth, the rice plant originally did not bear any grains. Then the Goddess Kuan Yin sprinkled her milk over the plant and white grains appeared, but excessive squeezing caused blood to come out and some grains became red (Sharma, 1991).

History:

The earliest record of colored rice is found in the Taittiriya Samhita of the Yajurveda [1200 BC (c. 7000 BC – editors)]. During this period, rice formed an important part of the ritual offering to God. A cake of black rice (Krishnavrihi) was offered to Agni (the God of Fire), a cake of red-grained to Brihaspati (the God of Speech), and a cake of large-seeded Mahavrihi to Indra (the God of Rain). The Satapatha Brahmana (1000 BC) refers to another variety of red rice, haryana, that was considered sacred and its pap was offered to Indra. (Uma Ahuja *et al* 2007)

What is red rice?

Rice with a red bran layer are called red rice. Though the color is confined to the bran layer, a tinge of red remains even after a high degree of milling. The color of the bran ranges from light to dark red. The bran layer contains polyphenols and anthocyanin, and possesses antioxidant properties. The inner portion of red and white rice is alike and white. The zinc and iron content of red rice is 2–3 times higher than that of white rice (Ramaiah and Rao, 1953). American scientists have reported similar high iron content in the Chinese red varieties 'Bloody Sticky' and 'Dragon Eyeball' (Rood, 2000).

Varieties:

Rakthashali, Thai Red Cargo rice (non-glutinous with long grain), Bhutanese red rice (medium-grain), Camargue red rice (Camargue region of southern France), Matta rice (Kerala), Patni of Maharashtra, and Jatu and Matali of the Kulu valley in Himachal Pradesh.

Nutritional profile:

- Protein:7.16-10.85
- Fat:1.15-3.19
- Crude fibre:0.28-0.61
- Crude ash:0.82-1.5
- Carbohydrate:70.75-81.29.
- Red-colored rice varieties are known to be rich in iron and zinc

Healthy benefits:

- **Diabetes mellitus:** Proanthocyanidins present in red rice protect against type 2 diabetes.
- **Cancer:** Proanthocyanins, present in red rice, modulate the inflammatory response and protect against some cancers
- **Cardiovascular disease:** Red rice contains magnesium that prevents the risk of heart attacks.
- **Hypertension:** High magnesium content plays a vital role in the regulation of blood pressure and sodium balance in the body.
- **Obesity:** red rice rich in fibre and can keep healthy bowel function and metabolic function. Anthocyanins present in red rice have properties that can help in weight management
- **Allergy:** anthocyanins present in red rice also have the property to reduce allergy

Red rice used in the treatment of ailments such as diarrhea, vomiting, fever, hemorrhage, chest pain, wounds and burns. Kafalya, from the hills of Himachal Pradesh and Uttar Pradesh, is used for treating leucorrhea and abortion complications. Kari kagga and Atikaya of Karnataka are used for coolness and as a tonic, while Neelam samba is used for lactating mothers in Tamil Nadu (Arumugasamy et al., 2001).

Traditional food and its importance:

- Varieties such as Bhama, Danigora, Karhani, Kalmdani, Ramdi, Muru, Hindmauri and Punaigora of Jharkhand and Chattisgarh are rich in nutrition and provide energy and satiety for a whole day.
- In Tamil Nadu, appams and idlis are also made using the red rice.
- Red gunja is preferred for making bread and chapati (Rani and Krishnaiah, 2001).
- In Japan is used for the preparation of red sake, colored noodles, and cakes for ceremonial occasions. In Sri Lanka, red rice are a favorite food.

Salient features:

Radical scavenging activity is higher in red rice than in black and white rice help to protect the cell from death. Red husked rice is comparatively more resistant to storage insect pests than brown-husked rice. In Japan, it has been reported that red rice grains stored since 1905 (Kitano et al., 1993) have remained intact and preserved their original status. Varieties are suitable for various agroclimatic conditions and adverse situations such as resistance to drought, flood, submergence, alkalinity, salinity, and resistance to pests and diseases.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Wetlands keep Environment healthy

Article id: 22815

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Water is very important for our life and without water the life on earth is not imagine, and wetlands are those natural and artificial land which provide life support system that ensure functioning of water cycle for lives hoods. A wetland is a separate ecosystem that is flooded by water, either permanently or seasonally. A wetland is an area between dry land and water that is frequently saturated with surface or ground water. Wetlands are surrounded by the most fruitful ecosystems on the earth and provide many essential services to human life. Natural wetland systems have often been described as the "Earth's kidneys" because they filter pollutants from water that flows through on its way to in receipt of lakes, streams and oceans. India is endowed by a rich diversity of wetlands ranging from high altitude wetlands of Himalayas, floodplains of mighty rivers as Ganges and Brahmaputra, lagoons and mangrove marshes on the coastline and reefs in the marine environments. Wetlands are rich reservoirs of biodiversity:

- 40% of the world's plant and animal species live or breed in wetlands
- Over 100,000 freshwater species have been identified in wetlands so far
- Coastal wetlands, especially, are among the most biologically diverse places

As per National Wetland Atlas, just about 4.7% of India's geographical area is under wetlands.

The main types of wetlands

A marsh is a wetland commonly or constantly filled with water. Marshes can be originate from coast and inland, and either freshwater or saltwater. Characterized by grassy, soft vegetation that grows in the soggy soil conditions, marshes can be one of two types tidal or non-tidal.

A swamp is any wetland denoted by woody plants and more than a few feet of water. Bogs collected most of their water from rainfall, rather than runoff or floodwaters. Their spongy, mossy floors contain smaller amount nutrients than a marsh or swamp. As the moss decomposes, it forms acidic peat. This peat is found low amount in nutrients, and it is only call a bog home, like salamanders, dragonflies, snakes and carnivorous plants. A fen is similar to a bog, except that a fen receives its water from the ground rather than from rainfall.

Sub-types of wetlands include mangrove forest, pocosin (with sandy peat soil and woody shrubs), floodplains, mire, vernal pool (seasonal pool), sink and many others. Many peat lands are wetlands. The water in wetlands is either fresh water, brackish, or saltwater. Wetlands can be tidal (inundated by tides) or non-tidal. The biggest wetlands include the Amazon River basin, the West Siberian Plain the Pantanal in South America and the Sundarbans in the Ganges-Brahmaputra delta.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Advantages of wetlands keep our environment healthy:

Carbon sequestration, Control flooding, Reduce Pollutions load, Increase groundwater**,** provide drinking water**,** Nutrient removal, toxics retention and improved the Biodiversity hotspots habitats**.**

Carbon sequestration:

Carbon cycle maintained by wetlands and play important role for environment. Swamps, mangroves, peat lands, mires and marshes wetland sediments are the long-term stores of carbon, short-term stores are in wetland existing biomass (plants, animals, bacteria and fungi) and dissolved components in the surface and groundwater. Though wetlands contribute about 40% of the global methane (CH_4) emissions, they have the highest carbon (C) density among terrestrial ecosystems and relatively greater capacities to sequester additional carbon dioxide (CO_2). Wetland soils may contain as much as 200 times more C than its vegetation. However, drainage of large areas of wetlands and their subsequent cultivation at many places had made them a net source of CO_2. As per the estimations, carbon sequestration potential of restored wetlands (over 50 year period) comes out to be about 0.4 tones C/ha/year (IPCC, 2000). In India, coastal wetlands are playing a major role in carbon sequestration. The total extent of coastal ecosystems (including mangroves) in India is around 43,000 km^2 (Kathiresan and Thakur, 2008). As carbon sink, mangrove wetlands in eastern India are more important than those on the west coast, as they are larger in size, higher in diversity and more complicated due to tidal creeks and canal net-work.

Control flooding: As with most wetlands, swamps main role as flood security and nutrient deduction. The waterlogged ground and standing water form a black, thick and nutritious soil, condition that helpful environment for water-tolerant shrubs and trees. They play an essential role in the survival of wetland-dependent animals, like ducks, snakes and otters. Wetlands act as a natural sponge, absorbing and storing excess rainfall and reducing flooding. Wetlands help to lessen the impacts of flooding by captivating water and reducing the speed at which flood water flows. Streams and wetlands can absorb significant amounts of rain and snowmelt before they flood, preventing that water from flowing downstream and putting homes and businesses at risk. Further, during periods of flooding, they trap suspended solids and nutrient load. Thus, streams flowing into rivers through wetlands will transport fewer suspended solids and nutrients to the rivers than if they flow directly into the rivers.

Reduce Pollutions load: Wetlands act as a sink for contaminants in many agricultural and urban landscapes. From an economic perspective too, wetlands have been suggested as a low cost measure to reduce point and non-point pollution. Natural wetlands, such as riparian wetlands, reduce the nutrient load of through-flowing water by removing nitrate and phosphorus from surface and subsurface runoff. Maximum potential rate of nitrogen and phosphorous removal by wetlands in the temperate regions ranges from 1000 to 3000 kg N/ha/year and from 60 to100 kg P/ha/year (Groffman and Crawford, 2003).

Filter pollution: Streams and wetlands trim down the pollution that flows to downstream rivers, lakes, bays and coastal waters. They help to trap nitrogen and phosphorus, which can cause environmental issues if they accumulate too much in one place. Small streams have been estimated to remove 20 to 40 percent of the nitrogen that otherwise would go downstream.

Improved the Biodiversity hotspots habitats: More than one-third of our country's threatened and endangered species live only in wetlands, and nearly half use wetlands at some point in their lives. For lots of flora and fauna, like wood ducks, muskrat, cattails and swamp rose, inland wetlands are the only spaces they can live. Some other, such as striped bass, peregrine falcons, otters, black bears, raccoons and deer, wetlands supply essential food, water or shelter. As with any other natural habitat, wetlands are important in supporting species diversity. Some vertebrates and invertebrates depend on wetlands for their entire life cycle while others only associate with these areas during particular stages of their life. Because wetlands grant an environment where photosynthesis can take place and where the recycling of nutrients can occurs, they play a significant role in the support of food chains. In India, lakes, rivers and other freshwater bodies carry a huge variety of biota on behalf of almost all taxonomic groups. The total numbers of marine plant species exceed 1200 and they provide a important source of food, mainly for waterfowl.

Increase groundwater: Streams and wetlands play a key role in recharging groundwater. At the time of dry weather, they discharge the water stored, delaying the onset of droughts and reducing water shortages. Streams and wetlands also play a serious role in providing clean drinking water by ensuring a continuous flow of water to surface waters and helping recharge underground aquifers.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Health Benefits of Bamboo - The green gold

Article id: 22916

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INTRODUCTION:

The bamboos (poor man's timber) are evergreen perennial flowering plants in the subfamily Bambusoideae of the grass family *Poaceae.* Bamboo tree is believed to be the most primitive tree due to its long valuable history, which produces 35 % more oxygen than an equivalent stand of trees. Found both in the temperate, tropical, and subtropical regions of the globe, this flowering rhizome-dependent plant is capable of adapting to harsh soil and weather conditions and an excellent soil erosion inhibitor. The bamboo plant comprises of 1200 species and approximately 90 genera.

India is the second richest country in bamboo genetic resources after China. These two countries together have more than half the total bamboo resources globally. Near about 136 species of bamboos occurring in India. Fifty-eight species of bamboo belonging to 10 genera are distributed in the north eastern states alone. It can survive for up to 20 years while the flowers can survive between 6 to 12 years but dependent on the type of species. It is distinguished from other trees due to its outstanding flexible nature whereby it can bend, twist and withstand windbreak and harsh weather conditions without breaking. Studies attribute the bamboo plant as the strongest woody plant in the world due to its ability to be drawn out or stretched with a high weight-to-strength ratio.

Bamboo is among the most valuable woody plant due to its numerous useful and beneficial purposes. Research published in the Indian Institute of Technology, Delhi reports that bamboo shoots are also consumed in many Asian countries such as China, Korea, Japan, Taiwan, Thailand, Philippines, Indonesia, Nepal, and India.

One can find evidence in old Chinese literature dating back to the Tang dynasty (618 AD- 907 AD), about the benefits of eating bamboo shoots. This was perhaps the first written record about these shoots in human history. Another important scripture dating back to the Ming dynasty (1368 AD to 1644 AD) also mentioned the medicinal and other benefits of bamboo shoots. In Japan, bamboo shoots are considered to be the "King of Forest Vegetables". There are many bamboo species that sprout shoots, but only a handful of them are cultivated and consumed.

Nutrient content of bamboo shoots (raw per 100 gm serving) according to a study in comprehensive reviews in food science and food safety, listed below: (Source: USDA)

Nutrient	**Value**	**Nutrient**	**Value**	**Nutrient**	**Value**
Water (gm)	91	K (mg)	533	P (mg)	59
Energy (kcal)	27	Vitamin C (mg)	4	Zn (mg)	1.1
Protein (gm)	2.6	Vitamin A (IU)	20	Fat (gm)	0.3
Carbohydrate	3-4	Vitamin B-6	0.24	Fiber (gm)	6-8
Calcium (mg)	13	Thiamin (mg)	0.15	Riboflavin (mg)	0.07
Mg (mg)	3	Niacin (mg)	0.6	Vitamin E (mg)	1
Sodium (mg)	4	Sugar (gm)	2.5	Iron (mg)	0.5

Health Benefits of Bamboo: The earliest scientific documentation of potential medicinal use of bamboo was published in the early 1960s (Sakai et al., 1963), followed by a series of studies carried out. In this article, recent findings on both health benefits and toxicity of extracts derived from different parts and species of bamboo has been summarized.

- **Nutritional values of Bamboo shoot:** Bamboo shoot is a rich source of amino acids, phosphorous, dietary fiber, magnesium, protein, iron, potassium, copper, selenium, vitamin B1, nicotinic acid, calcium, zinc, sodium, riboflavin, carotene, and essential minerals.
- **Weight Loss:** Bamboo shoots are weight loss-friendly. When we look at the number of calories, carbohydrates, and sugars contained in them, it is surprising to find that they are almost negligible. This makes them an ideal food for people who want to lose weight, but also want their stomachs to be full.
- **Antioxidant:** Ibeh et al., reported in 2013 phytochemical constituents and in vitro antioxidant capacity of methanolic leaf extract of Oxytenanthera abyssinica. *Phyllostachys nigra* commonly known as "black bamboo", this is another major species in the genus *Phyllostachys*. Flavonoids extracted from black bamboo leaves have potent antioxidant activities (Hu et al., 2000; Zhang et al., 2002).
- **Protection of Heart Health:** According to some research, phytosterols and phytonutrients found in bamboo shoots are ideal for dissolving harmful LDL cholesterol in the body.
- **Balanced Cholesterol Levels:** A research conducted by Park and Jhon at Washington State University showed that the consumption of bamboo shoots had favorable effects on LDL (bad) cholesterol, lipids, and bowel function.
- **Anti-cancer Properties:** A research paper published (Sakai S, 1963) the phytosterols found in the plant consist of potent anti-cancerous properties against major cancer types such as lung cancer, stomach cancer, ovary cancer, and estrogen-dependent human breast cancer.
- **Strengthened Immune System:** The vitamins and minerals in bamboo shoots are ideal for improving the body's immune system. The vitamins, minerals, and antioxidants present in bamboo shoots are essential for strengthening the body from inside-out – even when it comes to potentially delay neurodegenerative disease.

- **Healthy Bowel Movements:** The amount of dietary fiber in bamboo shoots is high. Consuming sufficient amounts of dietary fiber is essential for easy digestion and healthy bowel movements.
- **Anti-inflammatory Properties:** According to research done by Carey, 2009 extract of Bambusa vulgaris leaves possess anti-inflammatory and analgesic (pain-killing) properties. They help in the healing of ulcers as well.
- **Respiratory Disorders:** Bamboo shoots have been known to be effective against some respiratory disorders. A decoction of the shoots can be prepared by boiling them twice. The first boil should be for 5 minutes followed by a second boil for about 10 minutes.
- **Anti-venomous Properties:** In Ayurvedic medicine, the ancient Indian science of medicine and lifestyle, it is believed that bamboo extracts contain anti-venomous properties.
- **Uterotonic Properties:** Traditional Chinese medicine believes that bamboo shoots can cause uterine contractions. According to the research paper published in Planta Medica, bamboo is one of the many plants listed among uterotonic plants.
- **Stomach Disorder Treatment:** Bamboo shoots are useful in treating stomach disorders. Bamboo leaves are also suggested as a remedy for intestinal worms and stomach disorders as well.
- **Blood Pressure:** Bamboo shoots contain a high amount of potassium. Potassium is highly beneficial as an electrolyte and is also very good for lowering and maintaining blood pressure.
- **Wound Cleaning:** Bamboo shoots are also used for cleaning wounds and sores.
- **Lower Antimicrobial Properties:** Singh et al., (2010) subjected the ethanolic and aqueous extracts of bamboo for antimicrobial activity against the strains of Staphylococcus aureus, E.coli, Bacillus, and P.aeruginosa. The results showed that bamboo extracts have an effective inhibitory ability against Staphylococcus aureus. Both the ethanolic and aqueous extracts proved highly effective comparable to penicillin.
- **Anti-diabetic Properties:** Bamboo shoots and its extracts can be used for preparing herbal medicines for regulating the blood sugar level. Black bamboo enhances the activity of aldose reductase and inhibits the formation of advanced glycation end products, and therefore may potentially have a role in the prevention of diabetic complications (Jung et al., 2007).
- **Digestion:** Studies have shown that bamboo strengthens and reinforces the stomach muscles. The stimulative properties increase bile and promote efficient digestion. This explains why bamboo is served as an appetizer to enable easy digestion of a meal and is even take as tea in some places.
- **Purifying Indoor Air:** Bamboo has rated a score of 8.6/10 by NASA in the list of plants that purify the air. It fights pollutants in the air, purifying the air from formaldehyde, xylene, and carbon monoxide.
- **Alleviates Constipation** Bamboo fiber is now being added to cereals to combat nation-wide constipation. Gram for gram, bamboo contains more fiber than lettuce and is a great natural remedy for constipation.
- **Anti-aging:** Experimental studies on anti-aging effect of the leaf-extract of *P. nigra* var. Henonis reported by Zhang, Y. and Tang, L. 1997.
- **Anxiety- and depressional:** Del Rosario A. (2012) reported Effects of a high-fat diet and bamboo extract supplement on anxiety- and depression-like neurobehaviours in mice.

- **Neurotransmitter:** A high level of acetylcholine, an important neurotransmitter in the cholinergic nervous systems of vertebrates and insects, has been found in the upper portion of bamboo shoots (Horiuchi et al., 2003).

CONCLUSION:

According to State Forest Report, the forest area, over which bamboos occur in India, on a conservative estimate, is 15.69 million hectares, in comparison to the last assessment done in 2011; there has been an increase of 1.73 million ha in the bamboo area. Out of the 22 genera in India, 19 are indigenous and three exotic. The annual production of bamboo in India is about 4.6 million tonnes; about 1.9 million tonnes is used by the pulp industries. On average, 250 air-dried culms weigh one tonne and the price per tonne of dry bamboo is Rs 1000 (auction rate). These showing that there is a huge scope in our country for bamboo cultivation. With the increasing population pressure, natural stands of bamboo are being indiscriminately cut for fuelwood and furniture. The common practice of 'jhum' cultivation in the northeastern states has resulted in genetic erosion of several bamboo species; overexploitation of some species for fuelwood and for the cottage industry has endangered others. Since natural variation is the genetic resources base required for selection and improvement, conservation of available genetic resource needs to be accorded the highest priority. Efforts have been taken by the NBPGR, New Delhi and its stations in Trichur, Shillong and Ranchi, ICFRE and ICAR (Indian Council of Agricultural Research) to collect and build up genetic diversity of bamboo for evaluation and maintenance. As per the union budget 2018, the National Bamboo Mission under Mission for Integrated Development of Horticulture started for the maintenance of bamboo plantations with adequate emphasis on production, product development, and value addition activities. So, the diversity of this fascinating plant has to be conserved, not just for financial reasons, but also more importantly in the revitalization of traditional sciences, technologies and its health benefits.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Biofortification methodology and uses

Article id: 22917

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Biofortification is the idea of breeding crops to increase their nutritional value. This can be done either through conventional selective breeding, or through genetic engineering. Biofortification differs from ordinary fortification because it focuses on making plant foods more nutritious as the plants are growing, rather than having nutrients added to the foods when they are being processed.[1] This is an important improvement on ordinary fortification when it comes to providing nutrients for the rural poor, who rarely have access to commercially fortified foods.[2] As such, biofortification is seen as an upcoming strategy for dealing with deficiencies of micronutrients in low and middle-income countries. In the case of iron, WHO estimated that biofortification could help curing the 2 billion people suffering from iron deficiency-induced anemia.

Methodology

- **Selective breeding**

Using this method, plant breeders search seed or germplasm banks for existing varieties of crops which are naturally high in nutrients. They then crossbreed these high-nutrient varieties with high-yielding varieties of crops, to provide a seed with high yields and increased nutritional value. Crops must be bred with sufficient amounts of nutrients to have a measurable positive impact on human health. As such, they must be developed with the involvement of nutritionists who study whether the consumers of the improved crop can absorb the extra nutrients, and the extent to which storage, processing, and cooking of the crops affect their available nutrient levels. Bread wheat with high grain iron and zinc has been developed through radiation breeding. This method is prevalent at present, as it is less controversial than genetically engineering crops. Harvest Plus, a major NGO in the development of biofortified crops primarily use conventional breeding techniques, and have not yet spent more than 15% of their research budget on genetically modified crops when conventional methods fail to meet nutritional requirements.

- **Genetic modification**

Golden Rice is an example of a GM crop developed for its nutritional value. The latest version of Golden Rice contains genes from a common soil bacterium Erwinia and maize, and contains increased levels of beta-carotene which can be converted by the body into vitamin A. Golden Rice is being developed as a potential new way to address vitamin A deficiency.

- **Seed Priming**

Seeds are considered to be an important part of crop life cycle as it influences the propagation of critical phases like germination and dormancy. Seed priming before sowing is considered to be one of the promising ways to provide value-added solutions to maximize the natural potential of seed to set the plant for maximum yield potential with respect to both quality and quantity. Positive effect on the shoot and root growth of seedlings of wheat (Triticum aestivum L.) when treated with iron-oxide nanoparticles. This innovative cost-effective and user-friendly method of biofortification has proven to increase grain iron deposition upon harvesting. Hence, the intervention of nanotechnology in terms of seed priming could be an economical and user-friendly smart farming approach to increase the nutritive value of the grains in an eco-friendly manner.

Uses

- **Low and middle-income countries**

Deficiencies of various micronutrients, including vitamin A, zinc, and iron are common in low and middle-income countries and affect billions of people. These can lead to, amongst other symptoms, a higher incidence of blindness, a weaker immune system, stunted growth and impaired cognitive development. The poor, particularly the rural poor, tend to subsist on a diet of staple crops such as rice, wheat and maize, which are low in these micronutrients, and most cannot afford or efficiently cultivate enough fruits, vegetables or meat products that are necessary to obtain healthy levels of these nutrients. As such, increasing the micronutrient levels in staple crops can help prevent and reduce the micronutrient deficiencies – in one trial in Mozambique, eating sweet potatoes biofortified with beta-carotene reduced the incidence of vitamin A deficiency in children by 24%.

This approach may have advantages over other health interventions such as providing foods fortified after processing, or providing supplements. Although these approaches have proven successful when dealing with the urban poor, they tend to require access to effective markets and healthcare systems which often just do not exist in rural areas. Biofortification is also fairly cost effective after an initial large research investment – where seeds can be distributed, the "implementation costs [of growing biofortified foods] are nil or negligible", as opposed to supplementation which is comparatively expensive and requires continued financing over time, which may be jeopardized by fluctuating political interest.

Research on this approach is being undertaken internationally, with major efforts ongoing in Brazil, China and India.

- **High-income countries**

Researchers at the University of Warwick have been looking for ways to boost the low selenium levels in British grains, and have been working to help develop a grain to be used in making bread biofortified with selenium.

Problems

Some people, while not opposed to biofortification itself, are critical of genetically modified foods, including biofortified ones such as golden rice. There may occasionally be difficulties in getting biofortified foods to be accepted if they have different characteristics to their unfortified counterparts. For example, vitamin A enhanced foods are often dark yellow or orange in color – this for example is problematic for many in Africa, where white maize is eaten by humans and yellow maize is negatively associated with animal feed or food aid, or where white-fleshed sweet potato is preferred to its moister, orange-fleshed counterpart. Some qualities may be relatively simple to mitigate or breed out of biofortified crops according to consumer demand, such as the moistness of the sweet potato, whereas others cannot be.

Where this is the case, care must be taken to convince the local farmers and consumers that the crop in question is worth growing and consuming. This can be done through improving the cultivation qualities of the plant, for example making the orange sweet-potato mature earlier than its white-fleshed cousin so it can be taken to market earlier. It can also be done through public health education, making the benefits of eating biofortified foods apparent to consumers. Trials suggest that the rural poor "will consume biofortified versions of food staples even if the color of the food has been changed…if they are educated as to the benefit". While other micronutrients such as zinc or iron can be added to crops without noticeably changing their taste or appearance, some researchers emphasize the importance of ensuring that consumers do not think that their food has been altered without their authorization or knowledge.

Some have criticized biofortification programs because they may encourage "further simplification of human diets and food systems", because "[biofortification is] a strategy that aims to concentrate more nutrients in few staple foods may contribute to further simplifying diets already overly dependent on a few carbohydrate staples." This may seem irresponsible, as lack of access to a diverse and balanced diet is the major cause of malnutrition. As a result, these critics urge caution, and the use of biofortification as part of a larger strategy involving diversification of foods in low and middle-income countries. Advocates of biofortification accept this as a long term strategy but warn that substantially increasing diet diversity will take "many decades and untold billions of dollars" and that biofortification could be an effective strategy to help reduce micronutrient malnutrition.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Trends in Nutraceuticals

Article id: 22918

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INTRODUCTION

Health refers to the state of physical, mental and social well-being in which free from illness and disease. Diet is important for achieving good health but due to poor food habits which leads to the more lifestyle disorders. Junk foods and processed foods are rich in calories and saturated fats which lead to high blood sugar and obesity. Nutraceutical is a new trendy concept which bridges the gap between the food and medicine.

The term nutraceutical was coined from nutrition and pharmaceutical in 1989 by Stephen Defelice. According to him "a nutraceutical is any substance that is a food or a part of food and provides medical or health benefits, including the prevention and treatment of disease". Such products may range from isolated nutrients, dietary supplements and specific diets to genetically engineered designer foods and herbal products.

There is a difference between functional food and nutraceutical. The functional food provides the body with the required amount of vitamins, minerals, fats, proteins, carbohydrates needed for its healthy survival. When functional food aids in the prevention and/or treatment of disease(s) and/or disorder(s) other than anemia, it is called a nutraceutical. Nutraceutical has advantage over the medicine because they avoid side effect, have naturally dietary supplement.

Benefits of nutraceutical:

- Detoxifying the body,
- Avoiding vitamin and mineral deficiencies,
- Restoring healthy digestion and dietary habit
- Preventing and treating CVD (Polyphenol, flavonoids)
- Diabetic neuropathy (Lipoic acid)
- Controlling obesity (Green tea extract, ephedrine)
- Preventing cancer (Phytoestrogen)
- Anti-inflammatory activities (Cucurmin)
- Treating the visual disorders (Lutein, zeaxanthin)
- Treating the Osteoarthritis (glucosamine)
- Treating Alzheimer's disease (β carotene, lutein, lycopene)

Market growth in India

ASA & Associates LLP report (2015) stated that Nutraceutical products consist of food supplements and vitamin/mineral supplements. Nutraceutical product market penetration in urban India is around 22.5%, while it is comparatively low in rural India at 6.3%. The reason behind the consequence is urban youth are more aware about fitness and body building so they need to buy protein supplements and energy drinks. For nutraceutical, marketers follow end-user demographic market segmentation (like infants, children, youngsters, women, senior citizens etc) and the marketing messages revolve benefits to the end users (like boosting energy, body health-bones, weight management).

Major players

- GSK Consumer Health Care – Horlicks, biscuits, oats, noodles, cereal bars
- Baidyanath Group (Kolkata) – Ayurveda products
- Amway
- Abbott Nutrition

Categories of food supplements

- Food product and supplements- 50%
- Malted beverages – 29%
- Fruit based products – 9%
- Pediatric nutrition – 5%
- Protein powder – 4%
- Sports products – 2%
- Clinical products – 1%

Classification of Nutraceuticals:

1. Probiotic

A probiotic can be defined as live microbial feed supplement, which when administered in adequate amounts beneficially affects the host animal by improving its intestinal microbial balance (FAO 2001; Fuller 1992). Examples of probiotic organisms are *Lactobacilli acidophilus*, *L.delbrueckii subsp. bulgaricus, Lactococcus lactis, Bifidobacterium bifidum.* Probiotics are available in various forms as powder form, liquid form, gel or paste or granule forms, capsule forms etc. Probiotic agents possess the properties of non-pathogenic, non-toxic, resistance to gastric acid, adherence to gut epithelial tissues producing antibacterial substances. (Suvarna and Boby 2005).). The benefits of probiotics are generally used to treat gastrointestinal (GI) conditions such as lactose intolerance, acute diarrhea and antibiotic associated GI side effects (Doron et al. 2005).

2. Prebiotic

Prebiotics are dietary ingredients that beneficially affect the host by selectively altering the composition or metabolism of the gut microbiota (Macfarlane *et al*. 2006). Examples like fructo-oligosaccharides (chicory roots, banana, tomato, alliums) raffinose, stachyose (beans and peas). These are short-chain polysaccharides that are not digested by humans. The health benefits of the prebiotics include improved lactose tolerance, antitumor properties, neutralization of toxins, and stimulation of intestinal immune system, reduction of constipation, blood lipids and blood cholesterol levels.

3. Dietary fibre

It is the plant material that is not hydrolyzed by digestive enzymes but digested by microflora in the gut. It can be classified into insoluble dietary fibre (celluloses, some hemicelluloses and lignin) which is fermented to a limited extend in the colon and soluble dietary fibre (β-glucans, pectins, gums, mucilages and hemicelluloses) that are fermented in the colon.

The benefits of dietary fibre are

- lowering the serum LDL cholesterol,
- improve glucose tolerance,
- increases fecal bulk
- improves serum lipoprotein values,
- lowers blood pressure level
- lower the risk of CHR, stroke, hypertension, diabetes, obesity, certain gastrointestinal disorders

Some potential negative effects of dietary fibre include reduced absorption of vitamins, minerals, proteins and calories. It is recommended that dietary fibre intake for adults are 20–35 g/day (Pilch1987) and for children are estimated to be 14 g/1,000 kcals. (Anderson *et al*. 2009).

4. Antioxidant

Vitamins like vitamin C, vitamin E and carotenoids are collectively known as antioxidant vitamins. These vitamins act both singly as well as synergistically for the prevention of oxidative reactions leading to several degenerative diseases including cancer, cardiovascular diseases, cataracts etc. Vitamin E and selenium has a synergistic role against lipid peroxidation.

- Lycopene, β- carotene, lutein, zeaxanthin (Singlet oxygen quencher)
- β- carotene (Peroxy free radical quencher)
- Vitamin C (Singlet oxygen quencher)
- Vitamin E (Singlet oxygen scavenger)

5. Omega-3-fatty acids

These are essential fats – the body can't synthesis but must take in the form of foods. They are an integral part of cell membranes throughout the body and affect the function of the cell receptors in these membranes. Alpha linolenic acid (ALA), eicosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA) are the Omega-3-fatty acids.

- Anti-arrhythmic (preventing or alleviating irregularities in the rhythm of the heart)
- Hypolipidemic (promoting the reduction of lipid concentrations in the serum)
- Antithrombotic (decreased arteriosclerosis)

6. Polyphenols

Polyphenols form a large group of phytochemicals, which are produced by plants as secondary metabolites to protect them from photosynthetic stress, reactive oxygen species. There are approximately 8,000 different classes of polyphenols, the most important being flavonols, flavones, flavan-3-ols, flavanones and anthocyanins. Tea (*Camellia sinensis*) is a rich source of polyphenols, such as catechins.

- Antioxidant,
- Anti-inflammatory,
- Anti-microbial,
- Cardio protective activities,
- Prevention of neurodegenerative diseases,
- Prevention of diabetes mellitus.

Regulatory aspects

The primary set of rules governing the nutraceutical market is the Dietary Supplement Health and Education Act (DSHEA) passed in 1994. Food Safety and Standard Authority has also issued regulations with respect to Licensing and registration of food business, manufacturing, packing and labeling, food product standard etc. Foreign Direct Investment Act passed recently in 2012 that also provide new opportunities for international firms to manufacture and sale nutraceutical products in India.

CONCLUSION

The nutraceutical industry is growing at a rate far exceeding expansion in the food and pharmaceutical industries. Wide variety of nutraceutical foods are available in the market which falls in the category of traditional foods and non-traditional foods. Traditional foods are natural, whole foods with new information about their potential health qualities. Whereas non-traditional foods are the outcome from agricultural breeding or added nutrients and/or ingredients like orange juice fortified with calcium. The use of nutraceuticals is important to obtain therapeutic outcomes with reduced side effects. But success of nutraceuticals depends on safety.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Role of Nanofertilisers for improving nutrient use efficiency in Crop Production

Article id: 22919

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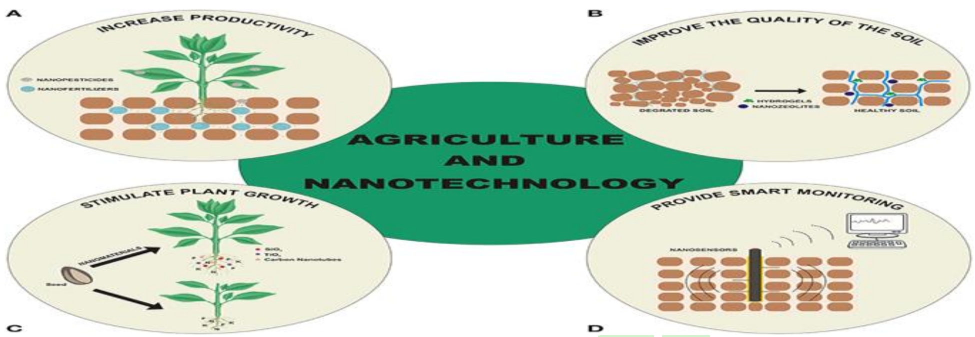
Nanotechnology has a great potential to improve the nutrient use efficiency that may reduce environmental impact, and boost the crop productivity. Nowadays Nanotechnology is getting advance technique in development of slow/controlled release fertilizers, conditional release of pesticides and herbicides, on the basis of nanotechnology has become critically important for promoting the development of environment friendly and sustainable agriculture. Nanotechnology has provided the feasibility of exploiting nanoscale or nanostructured materials as fertilizer carriers or controlled-release vectors for building of so-called "smart fertilizer" as new facilities to enhance nutrient use efficiency and reduce costs of environmental protection. Encapsulation of fertilizers within a nanoparticle is one of these new facilities which are done in three ways a) the nutrient can be encapsulated inside nanoporous materials, b) coated with thin polymer film and c) delivered as particle or emulsions of nanoscales dimensions. In addition, nanofertilizers will combine nanodevices in order to synchronize the release of fertilizer-N and -P with their uptake by crops, so preventing undesirable nutrient losses to soil, water and air via direct internalization by crops, and avoiding the interaction of nutrients with soil, microorganisms, water, and air. From these article, it was concluded that the Application of nano-fertilisers improves Nutrient use efficiency and crop productivity.

INTRODUCTION:

Nanotechnology is the branch of technology that deals with dimensions and tolerances of less than 100 nanometres, especially the manipulation of individual atoms and molecules.
Potential applications of nanotechnology in agriculture.

(A) Increase the productivity using nanopesticides and nanofertilizers.
(B) Improve the quality of the soil using nanozeolites and hydrogels.
(C) Stimulate plant growth using nanomaterials (SiO_2, TiO_2, and carbon nanotubes).
(D) Provide smart monitoring using nanosensors by wireless communication devices.



Nanotechnology is a novel scientific approach that involves the use of materials and equipment capable of manipulating physical as well as chemical properties of a substance at molecular levels. On the other hand, biotechnology involves using the knowledge and techniques of biology to manipulate molecular, genetic and cellular processes to develop products and services and is used in diverse fields from medicine to agriculture. Nano biotechnology can improve our understanding of the biology of various crops and thus can potentially enhance yields or nutritional values, as well as developing improved systems for monitoring environmental conditions and enhancing the ability of plants to absorb nutrients or pesticides. Some of advantages related to transformed formulation of conventional fertilizers using Nanotechnology are presented below. Smart fertilizers such as nano-fertilisers might become reality through transformed formulation of conventional products using nanotechnology. The nano-structured formulation might permit fertilizer intelligently control the release speed of nutrients to match the uptake pattern of crop. Solubility and dispersion for mineral micronutrients cause Controlled release formulation. Nanosized formulation of mineral micronutrients may improve solubility and dispersion of insoluble nutrients in soil, reduce soil absorption and fixation and increase the bio-availability leads to increased Nutrient uptake efficiency.

Nano fertilizers are synthesized or modified form of traditional fertilizers, fertilizers bulk materials or extracted from different vegetative or reproductive parts of the plant by different chemical, physical, mechanical or biological methods with the help of nanotechnology used to improve soil fertility, productivity and quality of agricultural produces. Nanoparticles can made from fully bulk materials. At nano scale physical and chemical properties are differ than bulk material. Rock phosphate if use as nano form it may increase availability of phosphorus to the plant because direct application of rock phosphate nano particles on the crop may prevent fixation in the soil similarly there is no silicic acid, iron and calcium for fixation of the phosphorus hence, it increase phosphorus availability to the crop plants.

Nano-fertilizer refers to a product that delivers nutrients to crops in one of three ways:

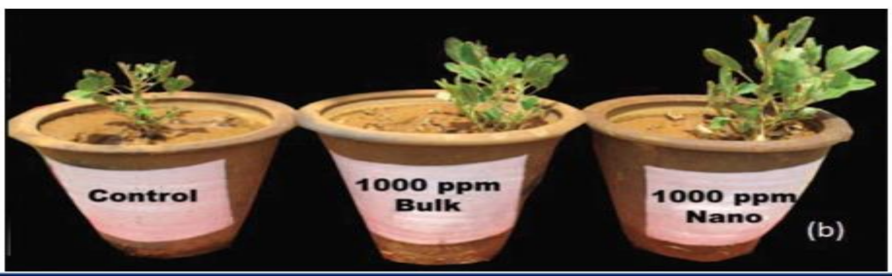
1. The nutrient can be encapsulated inside nano-materials such as nanotubes or nanoporous materials.
2. Coated with a thin protective polymer film.
3. Delivered as particles or emulsions of nano scale dimensions.

Nanofertilisers are Slow, targeted, efficient release becomes possible. In some cases, the nano particles itself can be used.

Effect of nanofertilisers for improving Nutrient use efficiency and crop productivity

Several research studies revealed that application of nano-fertilizers significantly increase crop yield over control or without application of nano-fertilzer it is mainly because of increasing growth of plant parts and metabolic process such as photosynthesis leads to higher photosynthets accumulation and translocation to the economic parts of the plant. Foliar application of nano particles as fertilizer significantly increase in yield of the crop.

Prasad et al. (2012) reported that application of nanozinc fertilizers gives significantly better results in germination, and shoot and rootgrowth (Lab Experiments in Petri dishes) and Seed vigour Index over common zinc sulphate and control treatment.



Pot culture experiment showing higher plant growth after nanoscale ZnO treatment (1000 ppm) after 110 days

Prasad *et al.* (2012) reported that in application of NPK+ZnO (Nano) @2g/15L resulted highest plant height (43.80 cm), no. of pods per plant (16.80) and no. of filled pods per plant (15) which was significantly superior over rest of the treatments.

Nano fertilizers provide more surface area and more availability of nutrient to the crop plant which help to increase these quality parameters of the plant (such as protein, oil content, sugar content) by enhancing the rate of reaction or synthesis process in the plant system. Application of zinc and iron on the plant increase total carbohydrate, starch, IAA, chlorophyll and protein content in the grain. NanoFe_2O_3 increase photosynthesis and growth of the peanut plant.

Advantages of Nano-fertilisers over Traditional fertilisers:

- Nanofertilizer increase soil fertility, yield and quality parameters of the crop, they are nontoxic and less harmful to environment and humans.
- Nanofertilizer increases higher nutrient use efficiency and minimizing the costs of environment protection.
- Improvement in the nutritional content of crops and the quality of the taste.
- Optimum use of iron and increase protein content in the grain of the wheat.
- Enhance plants growth by resisting diseases and improving stability of the plants by anti-bending and deeper rooting of crops.
- Balanced fertilization to the crop plant may be achieved through nanotechnology.

CONCLUSION:

Nanotechnology will play a vital role in the development of the agricultural sector, as it is capable of being used in agricultural products that protect plants and monitor plant growth and detect diseases. Nano-fertilizer certainly has the potential to improve agriculture production and they release the fertilizer slowly and extend the fertilizer effective period resulted in higher crop yields. Application of different nano-fertilizers have plays greater role in enhancing crop production this will reduce the cost of fertilizer for crop production and also minimize the pollution hazard.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Concept of Watershed Management

Article id: 22920

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INTRODUCTION

Watershed describing an area, surrounded by a ridge line, which drains its runoff through a single outlet. Chow, (1962) defined watershed is the separating one drainage basin from another drainage basin. An area that captured precipitation and convey the overland flow and runoff from the entire area to an outlet or main flow channel. The land bounded vertically by the area affected by human action and horizontally by the water that flow into a point in the channel. Within watershed area we have a system consisting of a number of dynamic and physical, social and economic factors (Narmada, 2015, Wani *et.al.* 2006). The Integrated Wasteland Development Programme started in 1990 seeks to develop government wasteland based on village or micro watershed level plans. The basic objectives of such type of programmes are "holistic development seeking sustainable livelihood security system for all life forms in the area". (Report, Planning Commission, 2008).

The man purpose of such type of study is to know about the characteristics of watershed, sustainable distribution of its natural resources and also include how to created and implemented the plans of project and enhanced watershed purpose that influence the plant, animal, human and other communities within the watershed. Watershed management including supply of water, quality of water, drainage area, runoff, water rights, erosion and other planning and utilization of the watershed resources. Landuse agencies, water management experts, environmental expert, surveyors and communities all play an important role in watershed management programmes. Agricultural practices like use of grassed waterways, re-initiate of wetlands and forms of sustainable agriculture practices such as conservation tillage, zero tillage, crop rotation and inter-cropping etc. We installed certain practices and insure that they continuously monitored and working satisfactory in terms of improving overall environment.

In urban lands to stop the deterioration of soil and manage storm water flow are a couple of the areas that receive attention. Some practices that are mostly used to control the runoff before it reach to the channel or ponds, filtering systems and wetlands. It is an important that the storm water is an opportunity to infiltrate it, that the soil as well as vegetation can play an important role, before water reaches nearby streams or lakes. The main objective in these cases is to slow water movement to prevent soil transport and its management.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Objectives of Watershed Management

The main objectives of watershed management is; to overall development of the watershed with minimum use of natural resource. The management of any watershed is to overall development of land use, water supply and quality, bio-resources within their capability and treated according to their needs (Dutta *et al*. 2004).

1. To reduce damage by floods and sediment deposits in cropland.
2. To protect and control the output of runoff from watershed.
3. To check the erosion of soil and control the quality of water.
4. To protect the soil against all forms of soil deterioration as well erosion.
5. To rebuild the eroded soil.
6. To build up strong soil fertility.
7. To stabilize overland flow and sediment producing areas in the watershed.
8. To harvest/conserve water for future use.
9. To provide necessary irrigation for crop.
10. To development the community which is directly or indirectly dependent on the watershed.
11. To rebuilt or restoration of ecological balance in the watershed.
12. To improve the living standard as well as economic and social conditions of the peoples those living in the watershed.
13. To increase infiltration and focus on ground water recharge.
14. To increase water holding capacity of the soil
15. To prevent soil erosion.
16. To build up of earthen embankment/dam for water storage.
17. To build up of check dams for ground water recharge as well as water harvesting.
18. To build up of farm ponds/storage structures.
19. To build up of diversion/grassed waterways.
20. To build up of permanent grass and vegetation.

Watershed Problems

1. **Physical Problems:** These are due to the existing physical nature of the watershed such as steep slope, bed lands; land slide, geologic formation etc.
2. **Resource Use Problems:** These are caused by the miss use of the resources in a watershed. Such as shifting agriculture, deforestation, forest-fire, over grazing, un-scientific mining etc.
3. **End Problem:** These are caused due to the effect of prolonged problems. Such as soil erosion, sedimentation, land slide, flood and drought etc.
4. **Socio-Economic Problem:** These problems are due to socio-economic problems like status of the people, education etc. in the watershed.

Levels of Watershed Planning

1. **National level:** At this level a rapid reconnaissance survey using aerial photography or satellite data is done to identify measure watersheds and there problems. Nature of the

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watersheds to the main problems and critical areas suffering from these areas. At this level a national policy can be determine and priorities are set.

2. **Regional Level:** The planning at this level is done specifically for a cluster of watersheds with other regional development plans. These planning are done in more restricted areas and are used in formulation of a long term development plans for the region.
3. **Watershed Level:** A watershed is a practical part which links the upstream and downstream areas in an integral structure. This planning is the most detailed planning. In large watersheds the detailed survey and planning is done or sub watersheds basis serious problems and critical areas suffering from these problems.
4. **Farm or Community Level:** Depending on the actual requirement the individual or group planning for community development can be carried out during the planning period or at the beginning of implementation and development on all resources.

Soil Erosion Control Using Watershed Management Approach: Soil erosion and runoff is the main problem of any watershed. The following steps are required to control soil erosion using watershed management.

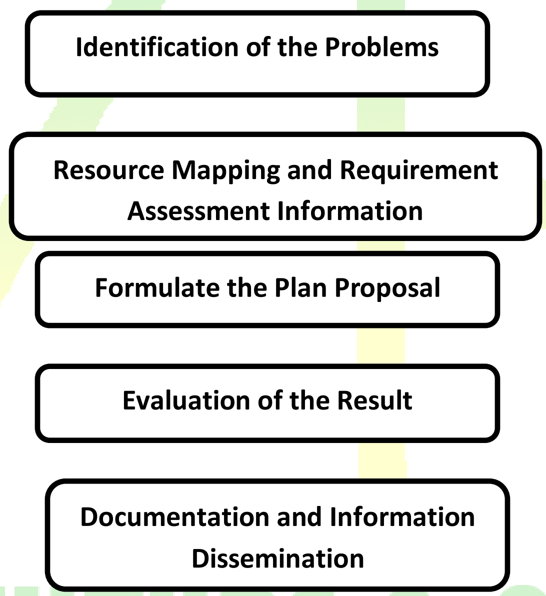

Fig. Flow Diagram of Watershed Management Steps

CONCLUSION

The term watershed management make use of the process and implementing of land resources or soil and also water management applications to preserve and upgrade the quality of the water as well as other unrefined resources within a watershed and by managing the use of those land and water resources as per need.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Organic Certification in India

Article id: 22921

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Organic farming is a system which primarily aims at cultivating the land and raising crops in such a way, as to keep the soil alive and in good health by use of organic wastes (crop, animal and farm wastes, aquatic wastes) and other biological materials along with beneficial microbes (bio fertilizers) to release nutrients to crops for increased sustainable production in an eco-friendly pollution free environment. It is very much native to this land. Whosoever tries to write a history of organic farming will have to refer India and China because the farmers of these two countries were farmers of more than 40 centuries and it is organic farming that has sustained them in the long run. This concept of organic farming is based on following principles:

- Nature is the best role model for farming, since it does not use any inputs or demand unreasonable quantities of water.
- Organic agriculture is based on understanding the mother nature and fulfilling the demands of agriculture.
- Soil contains several millions of beneficial microorganisms and they must not be curtailed as they contribute to fertility of soil and help in killing of harmful microorganisms.
- Conservation of biodiversity and eluding the use of chemicals.

Organic certification

It is a certification process for producers of organic food, seeds and other organic agricultural products. In general, any business directly involved in food production can be certified, including seed suppliers, farmers, food processors, retailers and restaurants. Organic seeds in general are double certified as they are certified twice, once by the seed certification team and again by the organic certification and monitoring team. Requirements for certification and seed demand vary from country to country, and usually involve a set of production standards for growing, storage, processing, packaging and shipping of organic produce that include:

- Avoidance of synthetic chemical inputs (e.g. fertilizer, pesticides, antibiotics, food additives, etc) and genetically modified organisms and seeds
- Use of farmland that has been free from chemicals for a number of years, if not at least for past three years (Conversion period)
- Maintaining strict physical separation of organic seed fields from inorganic seed fields is a mandate (Buffer zone)
- Undergoing periodic on-site inspections

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Purpose of organic certification

As of now there is no organic seed certification system in India but there are separate bodies that do organic certification and seed certification. This organic certification addresses the need of growing worldwide demand for organic food. It is intended to assure quality and prevent fraud. For organic producers, certification identifies suppliers of products approved for use in certified operations. Certification is written assurance given by Certification board that an identified production and processing system is methodically assessed and confirms to meet the specific requirement of organic standards. In India all the organic products meet the standards prescribed by the NPOP. In Tamilnadu organic certification is done by Tamilnadu Organic Certification Department.

Certification process

In order to certify a farm, the farmer is typically required to engage in a number of new activities, in addition to normal farming operations: Study the organic standards, which cover in specific detail what is and is not allowed for every aspect of farming, including storage, transport and sale.

Steps in organic certification

1. **Receipt of application form:** the farmer intending to get his farm organically certified must apply to the organic certification board. In Tamilnadu the organic certification is done by TNOCD (Tamilnadu organic certification department). The documents required for applying are duplicate of application form, Pan card, Annual cropping pattern, Field map, General details of the farm, Soil and water analysis report, Chitta (land documents), a written annual production plan must be submitted, detailing everything from seed to sale (seed sources, field and crop locations, fertilization and pest control activities, harvest methods, storage locations, etc.)
2. **Scrutiny and registration of application:** the application received along with the others farm or field details are verified by the inspector if it meets the requirements then the application is forwarded for the registration. For the registration the farmer must pay a prescribed amount. Once the farm is registered it must be strictly maintained under the organic conditions only.
3. **Inspection and evaluation of the farms and documents:** annual on-farm inspections are required, with a physical tour, examination of records, and an oral interview is done. Record keeping written, day-to-day farming and marketing records maintained and will be checked, the farmers must have covered all activities like biodiversity conservation and buffer zone. The farmer must be available for inspection at any time. In addition, short-notice or surprise inspections can be done by the certification officer.
4. **Sampling of soil, water and plant products if necessary:** if the certification officers doubt that the grower has done a mal practice then he has all the right to collect the soil, water and plant sample. Analysis of plant and soil sample will be done and if the results indicate the presence of any chemicals or toxic substance then their certificate will be taken back.
5. **Issue of certificate to eligible organic farms:** if the grower has maintained his farm purely under organic condition then a certificate will be given to him assuring others that he is an

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organic grower. The certificate is online generated, and it takes around six months from date of application.

Organic standards

1. **Conversion period** it is the time required for the conversion of inorganic field to completely organic field. Its two years for annuls and three years for perennials.
2. **Buffer zone**: Area of three-meter square must be left in border of field to separate the organic field from inorganic field. If the organic field is in low regions, then there must be a drench dug to avoid entry of polluted water in the form of runoff to organic field.
3. One per cent of area must be covered under the trees to protect the biodiversity and the farm must have a live fencing.
4. **Selection of crop and variety**:- the crop must be suitable to the area and season. The seeds used must be organic if such seeds are not available then the farmers can use the commercial seed in the first year and from the consequent year he must use the seeds that are produced in his farm.
5. The crops grown must be divers as it avoids loss to grower.
6. Only biodegradable material of microbial, plant or animal origin should be used, minimize nutrient loss is needed and accumulation of heavy metals and other pollutants must be prevented.
7. Origin farm must encourage the soil and water conservation.
8. Weeds should not be controlled chemical method.
9. No use of synthetic growth regulators.

Registration can be done by

1. **Individual farmers:-** the farmer willing to register a field under organic must be a legal owner of the land and there no limit of area for certification.
2. **Group :-** all the members of the group must be within the revenue district and no restriction on the area for certification but numbers of farmers with more than 10 ac of land should be less than 50 per cent of total area of group.
3. **Corporate bodies:-** group of farmers can come together and register as a corporate body. They can produce organically, process and sell but there should be an office setup to monitor the activities.

Certification & Product Labelling

Being able to put the word "organic" on a food product is a valuable marketing advantage in today's consumer market as people have become more health conscious. Certification is intended to protect consumers from misuse of the term organic, and make buying of organic products an easy task. However, the organic labelling made possible by certification.

In India the following certificates and labels are mandate to produce, sell and export any organic produce.

1. Scope certificate- This is the certificate that is provided by the organic certification agency which ensures that field is maintained organically according to the NPOP standards. The

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certificate needs to be renewed every year by paying a prescribed fee. Scope certificate contains the following details of the organic grower and the field.

2. Transaction Certificate- Transaction Certification is an authorization certificate given by APEDA stating that the products or stocks mentioned in transaction certificate has been produced and/or prepared in compliance with the current NSOP/NPOP standards. This certificate shall also be issued to the seller, if the seller provides the required details after the verification by the Organic Certification Inspector and evaluator.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

CSSLs: a modern tool for utilization of existing variation from germplasm to cultivated varieties

Article id: 22922

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INTRODUCTION

Population increases day by day. The expected population globally nine billion on 2050. The food security for the nine billion peoples globally is the challenging for the breeders. But the major crops like rice, wheat and maize are almost reached the yield plateau (Grasini *et al*., 2013). The main reason is that genetic erosion due to use of narrow genetic base in developing varieties. To create the variation for the selection and improvement of the crops we need wild forms and wild relatives. Prebreeding is the connection between cultivar and germplasm as direct crosses have barriers like lethal genes endosperm abortion etc. Most of the time conventional mapping population like RILs, DH and F2 are not involved in crosses of interspecific. Advanced mapping population like CSSLs involves interspecific and act as a genetic resource for crop improvement (Jacquemin *et al*., 2013).

Chromosome segment substitution lines (CSSLs) are genetic stocks representing the complete genome of any genotype in the background of a cultivar as overlapping segments. Ideally, each CSSL has a single chromosome segment from the donor with a maximum recurrent parent genome recovered in the background. CSSL development program requires population-wide backcross breeding and genome-wide marker-assisted selection followed by selfing. Each line in a CSSL library has a specific marker-defined large donor segment. CSSLs are evaluated for any target phenotype to identify lines significantly different from the parental line (Ali *et al*., 2010).

These CSSLs are then used to map quantitative trait loci (QTLs) or causal genes. CSSLs are valuable prebreeding tools for broadening the genetic base of existing cultivars and harnessing the genetic diversity from the wild and distant-related species. These are resources for genetic map construction, mapping QTLs, genes or gene interactions and their functional analysis for crop improvement. In the last two decades, the utility of CSSLs in identification of novel genomic regions and QTL hot spots influencing a wide range of traits has been well demonstrated in food and commercial crops (Balakrishnan *et al*., 2018).

History

CSSLs were first reported as introgression lines in tomato (Eshed and Zamir 1994, 1995)

Then reported as contig lines in rice (Ghesquire et al. 1997; Doi et al. 1997).

Several populations of CSSLs were developed in model plants such as Arabidopsis and used for studies on epistatic interaction and heterosis (Koumproglou et al. 2002; Kubo *et al*. 2002; Keurentjes et al. 2007; Torjek et al. 2008; Fletcher et al. 2013; Goulet et al. 2017).

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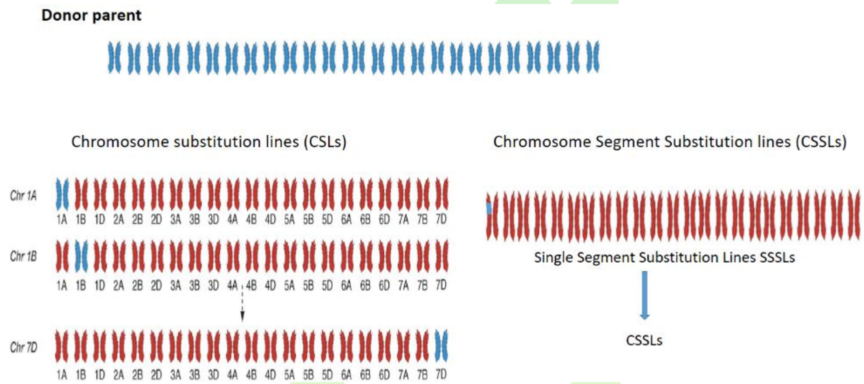
Concept

In CSSLs two parents called donor and recurrent parents. The figure bellows shows the blue coloured chromosome indicates the donor and red colour indicates the recurrent chromosome. In CSLs whole chromosome of recurrent parent is replaces by the donor parent chromosome. But in case of CSSLs a segment of the chromosome is substituted into the recurrent genome from the donor genome. The main event responsible for this is the crossing over and the recombination. The segment substituted can be identified using the markers. If a segment is substituted in the recurrent genome called SSSLs. In that way the whole genome is covered by number of SSSLs called CSSLs.



Development of chromosome segment substitution lines (CSSLs)

CSSLs are developed by continuous marker-assisted background selection with the aim of having only a specific donor segment in each SSSL.

1. Backcross breeding between recurrent and donor parent.
2. Genotyping the backcross progenies for tracking the donor chromosome segments in recurrent background.

These two steps are conducted simultaneously and finally a set of lines each with a specific target chromosome segment is selfed to create a complete CSSL library for further evaluation.

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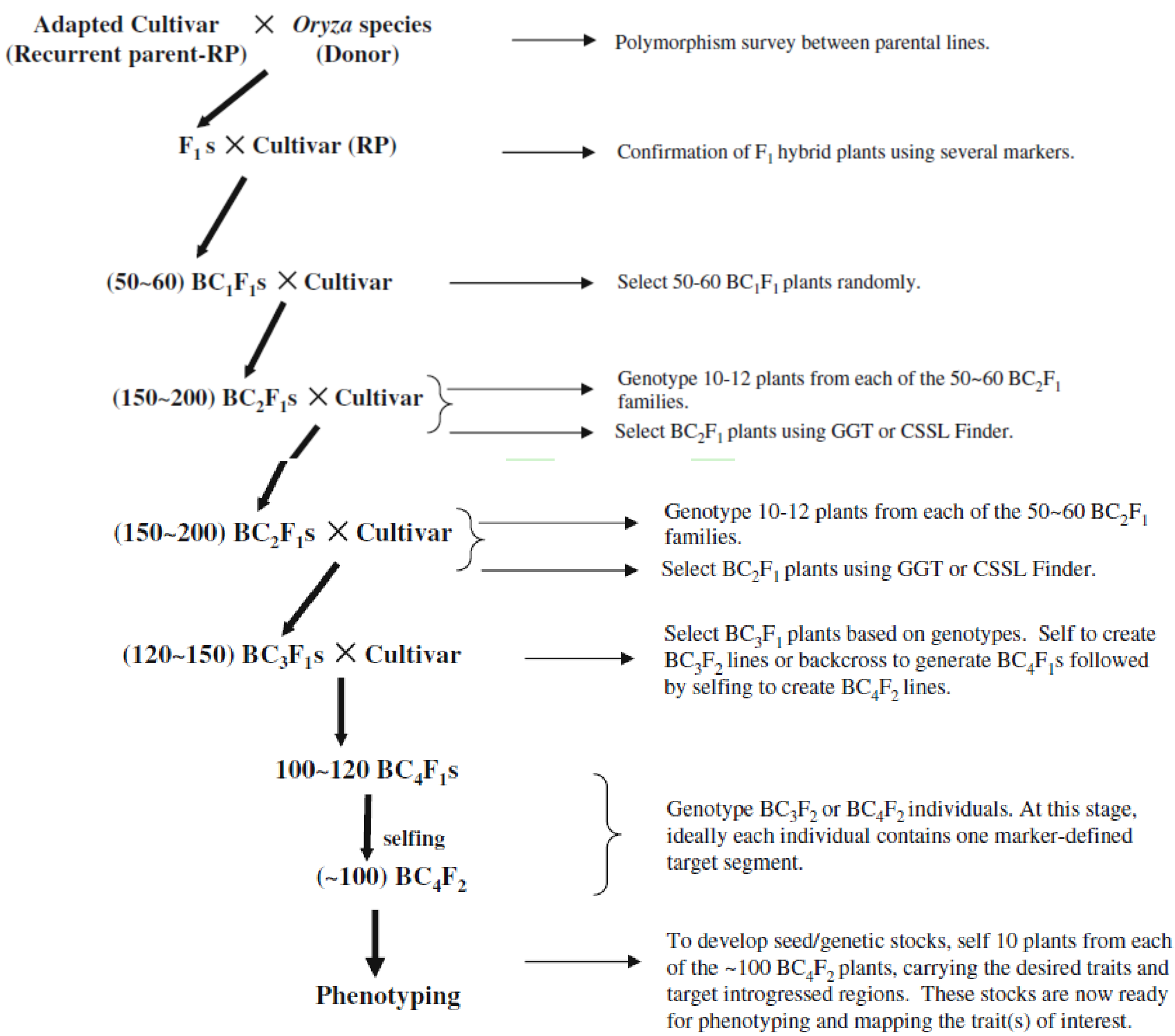
Backcross scheme for developing CSSLs



Applications of CSSLs

- QTL mapping and gene discovery.
- CSSLs as genetic stocks for functional genomics research.
- CSSLs for hybrid improvement.
- CSSLs act as lines with improved traits can be directly release as variety.
- Prebreeding and developing CSSLs can easily be a component in breeding programmes.

QTL mapping and gene discovery

- CSSLs contain marker-defined chromosome segment(s) from agriculturally unadapted donor plants in the background of an adapted cultivar.

- Differences between CSSLs and their parental lines must be due to the genes and QTLs located in the introgressed regions.
- CSSLs are considered excellent starting materials for dissecting complex traits into a set of monogenic loci.
- Through additional backcrossing and selfing of CSSLs, NILs can be generated for fine mapping genes, as well as, for precise estimation of the effect of each gene after testing in multiple environments.
- CSSLs are a powerful tool as they can be used to systematically detect QTLs with small additive effects that are masked by QTLs with larger effects in primary mapping populations, such as F2 populations or RILs (Ebitani *et al.* 2005; Keurentjes *et al.* 2007).

CSSLs as genetic stocks for functional genomics research

Most of the functional genomics depends on the genetic stocks of genome wide insertion deletion mutants.

The major limitation of using mutants for functional genomics research is

- The absence of detectable (visible) phenotypes for most mutants even when the disrupted gene(s) in a mutant line is known.
- It remains an unanswered question as to whether the mutant stocks with single gene mutations are suitable for functional genomics studies of complex phenotypes.
- Even though in rice there is advancement in genome sequence and QTL cloning, it is time consuming and labour intensive.
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- Even though in rice there is advancement in genome sequence and QTL cloning, it is time consuming and labour intensive.

CSSLs for hybrid improvement

- For the creation of interspecific or intersubspecific hybrids; instead of directly using wild accessions with desirable traits, CSSLs of the donor parents in the background of cross-compatible parental lines can be employed.
- Crossing a set of CSSLs as seed parent (A line) with a specific pollen parent (R line) or a tester and identifying the best combinations with highest heterosis is a useful strategy in heterosis breeding programmes.
- CSSLs can be developed in elite parental backgrounds with new donors for *Rf* (restorer of fertility) genes and can be studied for floral biology related to outcrossing traits to identify novel *Rf* gene donors in elite background.
- It also helps in dissecting the chromosome segments associated with heterosis and heterotic QTL in interspecific and intersubspecific crosses (Yu *et al.* 2005).
- Test of dominance is also possible comparing homozygous CSSLs with heterozygous CSSLs (Nadeau *et al.* 2000).

- CSSLs are recommended for heterosis analysis to avoid genetic drag arising from incompatible epistasis while using distant hybrids.

CSSLs lines with improved traits can be directly release as variety

- CSSLs made of recurrent parent where a segment is substituted by the wild species.
- If the substituted segment is improved the character of the variety (recurrent parent) then there is the scope for the release of the CSSLs directly as the new variety or as the improved version of that variety.
- The SSSL W14-18-6-10-1, which carries the purple pericarp gene *Pb* in the substituted segment on chromosome 4 from Lianjian33, was selected from the SSSL library. After comprehensive evaluation, the SSSL became a new variety designated Huaxiaohei, which was released in 2005.
- Furthermore, a pyramiding line with three substituted segments in an HJX74 genetic background was designated Huabiao1 and released to farmers in 2009 (Dai *et al.* 2015).

CSSLs as prebreeding material

- Variability in the cultivated genotypes are reduced due to use of narrow genetic base lead to the genetic erosion.
- Variation is the key factor for the selection in breeding programmes.
- Wild forms and wild relatives are the reservoir of the variation and contains desirable traits.
- Since they are difficult to cross with the improved cultivars due to several barriers like seed germination, vigour, linkage drag etc.
- Hence necessity of using prebreeding material to tackle the problems.
- CSSLs consist of wild genome segments which can be used as the prebreeding material for transfer of elite traits from wild species to cultivates one.

CONCLUSION

Several new technologies are evolving day by day. The new technologies are evolving in such a manner that one will outdate the other sometimes. CSSLs are the advanced mapping population which out dates RILs, DH and F2 in coming days. High throughput sequencing technologies are further supporting the advances mapping population. Variations are necessary for breeders to selection which is present in germplasm and can be transfer as a prebreeding material called CSSLs library act as genetic recourse for valuable traits.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Potential transformation of waste to asset: Use of flyash in agriculture

Article id: 22923

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INTRODUCTION:

Coal is comprehensively used as the major combustive fuel in thermal power plants for power generation, approximately 70% in India. Fly ash is produced by burning coal in pulverized coal combustion boilers (Jambhulkar et al., 2018). India ranks third amongst other countries namely Italy, Greece, Japan, Australia, Europe, United States, China and South Africa etc. (Ram et al., 2008). Hence, managing fly ash as a challenging task deserves special consideration. In India, fly ash generation increased from 70 MT in 1997 to 185 MT in 2015 (Surabhi, 2017). Disposal of high amount of fly-ash from thermal power plants associates requirement of huge quantity of water, energy and land area by ash ponds, thereby aggravating the concern (Sahu et al., 2017). This led to the research of utilizing this waste material in ancillary sectors, among which agriculture sector have emerged as a valuable one.

Major pros and cons of using flyash:

Flyash (FA) contains essential macro-nutrients like P, K, Ca, Mg and S and micro-nutrients including Fe, Mn, Zn, Cu, Co, B and Mo. The pH of FA can vary from 4.5 to 12.0 depending largely on the sulphur content of the parent coal and the type of coal used for combustion affects the sulphur content of FA. Use of FA in agriculture provides a feasible alternative for its safe disposal to improve the soil environment and enhance the crop productivity (Sahu et al., 2017). However the major hindrances in the commercialization of FA as a fertilizer in agricultural sectors is their content of non-essential elements (e.g. As, B, Cd, Se) that adversely affect crop and soil. Further, the poor content of nitrogen (N is absent because it is oxidized into gaseous constituents during the combustion) and P (excessive Fe and Al convert soluble P to insoluble P compounds, which are not readily available to plants), ash disposal with potentially toxic elements (as B, Se, Ni, Mo and Cd), high salinity and reduced solubility of the some nutrients from the high pH of some FAs are the major cons.

Flyash… Impacts on soil physical, chemical and biological fertility:

Among the physical properties of the soil affected by FA application, it was interesting to note that the sandy soil could be permanently altered regarding soil texture with increased micro porosity and improved the water holding capacity (Ghodrati et al., 1995). The particle size range of FA is similar to silt and changes the bulk density of soil. Application of FA at 0, 5, 10 and 15% by weight in clay soil significantly reduced the bulk density and improved the soil structure, which in turn improves porosity, workability, root penetration and moisture-retention capacity of the soil (Korcak, 1995). The Ca in fly-ash readily replaces Na at clay exchange sites, imparting flocculation of soil clay, maintains soil friability, improves water penetration and favours root penetration (Jala and Goyal, 2006).

Most of the fly ash produced in India is alkaline in nature; hence, its application to agricultural soils could increase the soil pH and thereby neutralize acidic soils (Phung et al., 1978). Lime component of FA readily reacts with acidic components in soil, helps in releasing nutrients such as S, B and Mo in the form and amount beneficial to crop plants and thus improve the nutrient status of soil (Robertson et al., 2000). The electrical conductivity of soil increases with FA application and so does the metal content. Metals like Fe, Zn, Cu, Mn, Ni and Cd have been shown to be available at higher concentrations in DTPA extracts of FA. FA being a rich source of Si, application of FA in Si-deficient soils improves its uptake in rice plants as well as their growth (Lee et al., 2006).

Information regarding the effect of fly ash amendment on soil biological properties is not well established (Schutter and Fuhrmann, 2001). The application of unweathered fly ash particularly to sandy soil greatly inhibited the microbial respiration, enzymatic activity and soil N cycling processes like nitrification and N mineralization (Cerevelli et al., 1986; Garau et al., 1991). It was interesting to note that mixed application of FYM and FA proved to be beneficial in augmenting proliferation and activity of microorganisms in acid soils (Sahu et al., 2017).

Flyash… Source of plant nutrients:

The chemical constituents of fly ash contain elements like Ca, Fe, Mg, and K that are essential to plant growth. The other elements such as B, Se, and Mo, and metals are the points of concern as they can be toxic to the plants (Inam, 2007; Lee et al., 2006). Lime in fly ash readily reacts with acidic components in soil leading to release of nutrients such as S, B and Mo in the form and amount favourable to crop plants (Jala and Goyal, 2006). FA contains negligible amount of soluble salt and organic carbon and adequate quantity of K, CaO, MgO, Zn and Mo. However, it is potentially toxic to plants due to high B content. Thereby alleviating the risk of the toxic chemicals present therein, flyash can be potentially adopted as a viable alternative source of plant nutrition.

Flyash… Improving crop growth and yield:

The use of fly ash as a soil amendment for the benefit of a large number of field crops has been widely reported. The safe and sustainable use of sewage sludge/fly ash combination on agricultural soils is considered to be a highly promising endeavor from environmental point of view (Schoeman and van Deventer, 2006). FA, having both the soil amending and nutrient enriching properties, is helpful in improving crop growth and yield in low fertility acid lateritic soils (Basu et al., 2007). This effect was reported by several studies as demonstrated in alfalfa (*Medicago sativa*), sorghum (*Sorghum bicolor*), field corn (*Zea mays*), millet (*Echinochloa crusgalli*), carrots (*Daucas carota*), onion (*Allium cepa*), beans (*Phaseolus vulgaris*), cabbage (*Brassica oleracea*), potatoes (*Solanum tuberosum*), tomatoes (*Lycopersicon esculentum*) etc. grown on a slightly acidic soil (pH 6.0) and thereafter treated with fly ash; although there was an increase in contents of As, B, Mg and Se. The crop response to fly ash application may vary significantly from beneficial to toxic depending on the concentration of various elements present in it (Kalra et al., 2000). Application of fly ash extract in the lower concentration range of 0.5–1.0% (w/w) had no significant effect on germination and seedling growth of corn and soybean, whereas higher concentration of fly ash extract had deleterious effect on germination, viability, number of roots, shoot and root length, fresh weight and dry matter of seedling of both the crops (Sikka and Kansal, 1994). This is not an isolated condition, as such effects of high concentration adversities have been reported by others in some other crops as well.

Other aspects of flyash application:

Flyash has an indirect role in the process of composting. In sewage sludge composting, lime is used to raise the pH and kill pathogens and also to reduce the availability of heavy metals enriched in sludge. Alkaline flyash containing large amount of CaO, can serve the purpose of lime and beneficiate the composting process in conjunction (Jiang et al., 1999).

FA also can be used in the reclamation of wastelands (sodic soil, acidic soil and mine spoil) as FA possesses many of the functional properties of lime and gypsum (Kumar and Singh, 2003). Pandey et al. (2009) also suggested the use of FA in the reclamation of wastelands.

Agricultural lime contributes a prime role in the global fluxes of the greenhouse gases such as carbon dioxide, nitrous oxide and methane. Utilization of FA in place of agricultural lime for minimizing global warming can emerge as a win-win situation (Bernoux et al, 2003).

CONCLUSION:

Fly ash, a multi nutrient solid waste of thermal power plant, can be effectively utilized in agriculture sector for improving the properties of problem soil, improve the trace element concentration and nutrient availability of degraded and nutrient deprived soil and will lead to a cost effective way of reducing the use of organic manures as a nutrient source. It can also provide a feasible alternative for its safe disposal without serious deleterious effects. Although the effects are not very well established, it can be stated that the lower dose can be a beneficiary one for soil, plant and environmental health rather than a higher dose of application. However, the bioaccumulation of toxic heavy metals and their critical levels for human health in plant parts and soil should be investigated. Thereby maintaining a harmony between the discrepancies can be the flag bearer for effective disposal and re-utilization of the so called waste into an asset having environmental managerial significance.

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Air Pollution and Its Effect on Crop Productivity

Article id: 22924

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Air pollution: Any atmospheric condition in which substances are present in such concentration that may produce undesirable effects both on human & ecosystem. It is the involvement of chemicals, particulate matter, or biological materials in the atmosphere that cause harm or discomfort to humans or other living organisms, or cause damage to the natural environment or built environment. Air pollution spreads through some kind of substances known as pollutants.

Major air pollutants: More than 3,000 substances that are not part of the atmospheric composition, falling in the atmosphere can be considered air pollutants.
The main air pollutants are represented by:

- **Gases forms-** oxidized and reduced forms of carbon (CO, CH_4), of nitrogen (NO_2, NO, N_2O_4, NH_3, NH_4^+), SO_2, O_3, C_6H_6 vapours, Hg, volatile phenols, Cl_2, etc.
- **Particulate forms-** pm 10 and pm 2.5 particulate matter, heavy metals with toxic effect (Pb, Ni Cd, As), polycyclic aromatic hydrocarbons (PAHs), etc.

Sources of pollutants: Air pollution comes from natural and anthropic sources. Natural processes that affect air quality include volcanoes, which produce sulfur, chlorine and ash particulates. Wildfires produce smoke and carbon monoxide. Cattle and other animals emit methane as part of their digestive process. Even pine trees emit volatile organic compounds (VOCs). Many forms of air pollution are human-made. Industrial plants, power plants and vehicles with internal combustion engines produce nitrogen oxides, VOCs, carbon monoxide, carbon dioxide, sulfur dioxide and particulates.

Effect of air pollution on agricultural crops: Crop production is highly dependent upon environmental conditions among which air quality plays a central role. Broadly, biochemical and physiological processes of plants are affected, which ultimately leads to yield losses. Responses of plants vary between different species and their cultivars and also depend on type of pollutants, concentrations duration and its magnitude.

Air pollutants pose risks on yield of crops depending upon:

- The emission pattern
- Atmospheric transport
- Leaf uptake
- Plant biochemical defense capacity.

Atmospheric pollutants have a negative effect on the plants; they can have direct toxic effects, or indirectly by changing soil pH followed by solubilization of toxic salts of metals like aluminum. The particulate matters have a negative mechanical effect. They cover the leaf blade reducing light penetration and blocking the opening of stomata. These impediments influence strongly the process of photosynthesis which rate declines sharply.

The plants play an important role in reducing atmospheric CO_2 content, by photosynthesis. This reduction of atmospheric CO_2 content has an important role in reducing of greenhouse gases, participating in reducing greenhouse effect and its consequences on climatic changes. The carbon stored in plants is the result of balance between carbon fixed by photosynthesis and carbon released in the atmosphere by respiration.

Visible effect on crops

- Growth becomes stunted.
- Loss of colour, necrosis and chlorosis.
- Water-soaked appearance, leaf cupping and abscission.
- Early senescence or leaf drop.
- Elongated stem and leaf structures and decreased yield.

Invisible effect on crops

- Reduced plant growth and alteration of physiological and biochemical processes and changes in the reproductive cycle.
- Alterations in net photosynthesis, stomatal response and metabolic activity. Reduced stomatal opening causing general water stress in plants.
- Swelling of thylakoid membrane.
- Affects the growth hormones and regulatory process that takes place in the plant and results in a number of outward manifestations of infection.

Effect of major air pollutants

Pollutant	Major impacts
Sulphur dioxide (SO_2)	Visible foliar injury; altered plant growth; elimination of lichens and bryophytes; forest decline
Nitrogen oxides (NOx)	Altered plant growth; enhanced sensitivity to secondary stresses; eutrophication
Ozone (O_3)	Visible foliar injury; reduced growth; forest decline
Suspended Particulate Matter (SPM)	Altered plant growth; enhanced sensitivity to secondary stresses
Fluorides	Altered plant growth; enhanced sensitivity to secondary stresses reduced plant growth; fluorosis in grazing animals

Some resistant and sensitive crops against the pollutants

Pollutant	Resistant crops	Sensitive crops
Sulfur dioxide	Asparagus, cabbage, celery, corn, onion and potato.	Alfalfa, barley, buckwheat, clover, oats, pumpkin, radish, rhubarb, spinach, squash, swiss chard and tobacco
Fluorides	Alfalfa, asparagus, bean (snap), cabbage, carrot, cauliflower, celery, cucumber, eggplant, pea, pear, pepper, potato, squash, tobacco and wheat.	Apricot, barley (young), blueberry, peach (fruit), gladiolus, grape, plum, prune, sweet corn and tulip
Ammonia	Alfalfa, beet, carrot, corn, cucumber, eggplant, onion, peach, rhubarb and tomato	Apple, barley, beans, clover, radish, raspberry and soybean
Ozone	Endive, pear and apricot	Cucumber, grape, green bean, lettuce, onion, potato, radish, rutabagas, spinach, sweet corn, tobacco and tomato

CONCLUSION: Air pollutants cause deleterious effects on physiology and metabolism of plants due to their oxidizing potential which ultimately, directly or indirectly effects the crop productivity.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Blue mold rot disease of onion

Article id: 22925

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INTRODUCTION-

Onion (*Allium cepa* L.) is one of the most important commercial vegetable and the oldest bulb crops, known to mankind and consumed worldwide. It is believed to be originated in Central Asia. It is valued for its distinct pungent flavor and is an essential ingredient for the cuisine of many regions in India Onion is the queen of kitchen according to The onion is native to south west Asia or Mediterranean, considered important commercial vegetable crop in the world. India ranks second in the production of onions next to China. Maharashtra stand alone contribution was 32.6 per cent in total production and the rest shared by Karnataka, Gujarat and Madhya Pradesh in India in UP area 26.6 hec and production is 474.01tonnes during 2012-13.Onion is one of the highly perishable vegetable in India. Onion is a valuable ingredient in the diet due to its content of sugars, vitamins and minerals, nutrient value per 100 gm carbohydrate 9.34gm, sugar 4.24g, dietary fiber 1.7g, fat 0.1g, protein 1.1g, water 89.11g, iron 0.21mg, calcium 23mg, zinc 0.17g, potassium 146mg. Onion is grown for its bulbs which are daily in every home for salad, seasoning and flavoring of foods. Onion has several medicinal uses as it is useful against sun strokes.

There are several pathogens like bacteria, viruses, insects & pests and especially fungi from the subdivision *Zygomycetes* and *Ascomycetes i.e* moulds are important fruits and vegetables pathogens under tropical and sub-tropical conditions mainly, causes storage rots that leads to the reduction in the quantity and quality of onion which affects the market value. The production of mycotoxin often overlooked and the consequence is the contamination of the infected bulbs. Onion storage is widely done as per the cultural and economical practices used worldwide. In India, method of storage adopted mostly depends on the traditional knowledge and commonly practiced methods are bag, pucca/room, tat storage, bamboo, chawl structure and the losses associated are quite higher. Sprouting, desiccation and microbial spoilage are often observed in storage. In production technology lot of achievements has been done, but the problem of storage of post-harvest losses still a great issue especially in India. As we know that onion is a *Rabi s*eason crop and bulbs are stored until the harvest of next season to avoid the scarcity in the market. It is observed that during storage significant losses in quality and quantity of onion occur that leads to a serious storage problem. The post-harvest losses in India reported that annual storage losses were over 40% and between 40 to 60% due to sprouting, rotting and physiological loss in weight.

Diseases of onion-

In India several factors have been identified for the low productivity of onion. The most important factors responsible are the diseases like black mould, basal rot, blue mould rot, damping off, downy mildew, leaf blotch, neck rot, purple blotch, rust, these are fungal diseases. Virus disease like iris yellow spot virus, onion dwarf bacterial disease like bacterial soft rot, *Xanthomoans* leaf blight, nematode diseases lesion nematode, root knot nematode, Stem and bulb nematode these are importants diseases of onion which is reduces the production of onion.

Blue Mold disease-

Blue Mold rot of onion may be caused by several *Penicillium* species. *Penicillium* decay of garlic caused by *P. hirsutum* is responsible for storage decay as well as poor plant growth in the field. Symptoms in the field include bulb decay soon after transplanting due to wilting, leaves become yellow, or stunted seedlings. Infected plants are weak and stands are poor. Other species of *Penicillium* causes Blue Mold on onions and may be prevalent on fresh plants. This fungi attack a wide range of fruits, vegetables, bulbs, and seeds; they are common in the soil growing on infected animal and plant debris. Disease symptoms start with pale blemishes, yellow lesions, and soft spots. A blue-green mold develops on lesions. By mechanical injury or by any other means if bulbs are cut up, discoloration of fleshy scales may occur and become water-soaked lead to complete decay of bulbs in advanced stages. In onion, the pathogens survive in infected bulbs.

Penicillium survives in infected bulbs from one season to the next. If slightly infected blubs are planted, they may rot before plants come up, or the seedlings may not survive. The fungus does not persist in the soil. In storage, infection or contact is through surface wounds or through the basal plate; the fungus grows through the fleshy tissue and sporulation occurs on the surface of the lesions. Entire cloves may eventually be filled with spores.

Symptoms-

Initial symptoms include water-soaked or pale-yellow areas on the outer surface of scales. Later, powdery mold may develop on the surface of the lesions a green to blue-green in color. When cut the infected areas of fleshy scales are tan or gray. Bulbs may disintegrate into a watery rot in later advanced stages of infection, often because of secondary infection caused by yeasts or bacteria. The first symptoms of the pathogenic fungus are an area covered with a blue sooty mass on the opening in the skin as neck or outer scales, where injury has caused. Spores of the fungal pathogen may develop on dead, dry outer scales first later on inner fleshy scales. Occasionally, interior parts of the bulb may be affected with gray-to-black discoloration without showing external symptoms. Under dry conditions, diseased scales dry and shrivel, and blue masses of spores are visible on the outer scales. Affected parts may also be invaded by soft rot bacteria, causing the whole bulb to deteriorate into a watery soft rot. The fungus survives on decaying organic matter such as plant debris, and is a weak pathogen that generally does not affect uninjured bulbs. The fungus is widely distributed among soil environments.

Management-

While some fungicide control programs used for foliar diseases may reduce the incidence of blue mold (with the exception of many fungicides applied to control the pathogen that causes

e-ISSN: 2581 - 8317
Volume 2 – Issue 2 – February 2020

downy mildew), there are no fungicides for the direct control of blue mold. Culturally manage blue mold by doing the following:

- Store and transport bulbs at temperatures below 59°F and at low humidity to slow growth of the fungus.
- Reduce bruising and injury during harvest, handling, and transport to minimize the opening of invasion sites for the fungus.
- Harvest onions promptly and do not delay drying. Do not use heated air for drying.
- Maintain stable temperatures during transport, as well as when bulbs are going into and coming out of storage.

Blue mold symptoms of onion bulb

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Response of boron to Field Crop production

Article id: 22926

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The post green revolution era has made the country net exporter of food grains. But to ensure national food security, country will require about 294 million tonnes of food grain production by 2020 to feed 120 million mouths. The increased demand of food grain production has led to continuous depletion of soil micronutrient fertility. As a result there is steady fall of nutrient use efficiency and that is partly attributed due to the increased incidences of deficiencies of zinc and boron in many parts of the country. Boron (B) is unique, not only in its chemical properties, but also in its role in biology. Among micronutrients, boron is indispensable for the normal growth and development of plants. Boron is important in agriculture because both its deficiency and toxicity in soils can adversely affect plant growth. Boron is one of the most commonly deficient of all the micronutrients after Zn. The extent of B-deficiency in India and Gujarat is about 33% (Singh, 2008) and 2% (Behera et al., 2014), respectively.

INTRODUCTION:

India has achieved record food grain production of 264 million tonnes in 2013-14 with annual growth of 2.6% since independence. About 50% increase in food grain production is attributed to fertilizers. The increased demand of food grain production has led to continuous depletion of soil micronutrient fertility. As a result there is steady fall of nutrient use efficiency and that is partly attributed due to the increased incidences of deficiencies of zinc and boron in many parts of the country (Singh and Goswami, 2014).

Boron (B) is unique, not only in its chemical properties, but also in its role in biology. The importance of boron as a plant nutrient was first demonstrated by Warington (1923).Boron is important in agriculture because both its deficiency and toxicity in soils can adversely affect plant growth. Boron is one of the most commonly deficient of all the micronutrients.

B deficiency is second most widespread and economically important micronutrient deficiency in crops. More than 90% of the B in plants is found in cell walls, and its most important role is associated with cell wall formation, functioning and strength. Species differ widely in their B requirements, being it higher for dicots than monocots because of the higher B concentration in their cell wall. B requirement is much higher for reproductive growth than for vegetative growth in most plant species because reproductive organs have a high concentration of pectin which is rich in B.

Forms of boron in soil:

1) **Rocks & minerals:**
   B occur in igneous and sedimentary rocks and tourmaline (borosilicate) mineral

2) **Adsorbed:**
B adsorbed on the surface of clay minerals and hydrous oxide of Fe& Al.
3) **Combined with organic matter:**
Boric acid form stable complex with organic compound (boron-organic matter complex)
4) **Soil solution:**
B exists as boric acid (H3BO3), borate ion (H2BO3-) and B(OH)4- (or H4BO4-) in soil solution. At pH <7.0 H3BO3 predominates & at pH >8.5 B(OH)4- predominates.

Forms of B absorbed by roots

- H_3BO_3 (Largely)
- $H_2BO_3^-$ (Small)
- HBO_3^{2-} (Small)
- BO_3^{3-} (Small)
- $B_4O_7^{2-}$ (Small)

Functions of boron

- Cell wall formation, functioning and strength
- Root and pollen tube elongation
- Growth of meristematic tissues
- Nodule formation and N-fixation in legumes
- Proper pollination, reproduction, fruit or seed setting
- Translocation of sugar, starch, P *etc.* in plants
- Synthesis of RNA, DNA, amino acids and proteins
- Formation of pectic mixture in central lamellae
- Water absorption and water control in cells
- Cell division
- Metabolism of N, K, Ca, protein and carbohydrate
- Formation of cortex
- Solubility and mobility of Ca in plant
- Regulation of K/Ca ratio in plant

Deficiency Symptoms of boron

- Deficiency symptoms first develop in newly developed plant tissue such as young leaves and reproductive structures.
- Stunted development and death of meristematic growing points.
- Reduced root elongation.
- Failure of flowers to set seeds and fruit abortion.
- Low B supply may also adversely affect pollination and seed set, without visible leaf deficiency symptoms.

Remedial treatment/control of B deficiency

- Soil application of B fertilizers
- Foliar spray with B fertilizer solution
- Liquid fertilizer application
- Regular application of bulky organic manures

Note:

1. If seeds are mixed with B fertilizers, seed germination may be restricted.
2. Boric acid can be safely mixed with ammonium fertilizers.
3. Solubor can be mixed with urea, dieldrin, parathion, 2,4-D, zineb, captan, bordeaux. It can not be mixed with oil.

Toxicity symptoms

- Appear on the older leaves
- Margin or leaf tip chlorosis
- Browning of leaf tips
- Death of the affected tissue
- Defoliation.

Remedial treatment/control of B toxicity

- Don't using irrigation water high in boron (B).
- Leaching the root zone with boron free water.
- Growing boron tolerant crops; beet, muskmelon, turnip, cotton *etc*.

Note: It is reported that above 1 ppm B in irrigation water becomes toxic to some of the sensitive crops. On the other hand, 0.5-1.0 ppm B in irrigation water may reduce occurrence of B deficiency.

Uptake of boron

- Uptake of boron is very unique.
- Boron reaches roots mainly by mass flow and is absorbed as boric acid, which is uncharged.
- In contrast to other nutrients, most crop species exhibit very little control of B uptake when its availability is in the adequate to toxic range.
- This response is a direct consequence of the passive uptake of B through plant membranes, in contrast to other nutrients that have specific transporters that regulate uptake.
- Consequently, plant B accumulation is directly related to transpiration and soil B concentration.

Factors affecting Boron availability

- **Soil pH:** High pH reduces, and low pH enhances availability.
- **Soil texture:** B is mobile, so coarse soils and high rainfall may cause temporary soil shortages.
- **Soil organic matter:** Organic matter is a reservoir for B, and many other nutrients.

- **Soil Moisture:** In moist soils B moves towards plant roots by diffusion or mass flow. In dry soil movement of B hindered.
- **Clay:** Montmorillonite clay adsorb more B than kaolinite clays.
- **Liming:** Liming increases soil pH. At high pH, Al precipitates as aluminium hydroxides. Soluble B adsorbed on aluminium hydroxides and precipitated.
- **Quality of irrigation water:** Irrigation water high in B causes B toxicity.
- **Interactions with other elements** When calcium availability is high, plants can tolerate higher B availability.

CONCLUSION

From ongoing discussion, it is concluded that soil application of Boron @ 1 to 2 kg/ha alone or combine B with S or Zn or Mo through boric acid at flowering and pod development stage in groundnut, soybean, green gram and seliqua development in mustard and leaf development in tobacco and booting, anthesis and joining stage in wheat and week after flowering in cotton enhance the growth, yield, quality, nutrients content and uptake and nutrients availability in field crops.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Vermicomposting- A tool for waste management

Article id: 22927

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INTRODUCTION

Waste is any material that is not useful as well as does not represent any economic value. Depending on the physical state of waste, wastes are categorized into solid, liquid and gaseous whereas solid wastes are categorized into municipal wastes, hazardous wastes, medical wastes and radioactive wastes. Municipal solid wastes (MSW) is defined as any waste generated by household, commercial and/or institutional activities and is not hazardous. on the basis of source, MSW can be categorized into three types: residential or household waste; commercial wastes or institutional wastes which occur from individually larger sources of MSW like hotels, office buildings, schools, etc.; municipal services wastes which arise from area sources like streets, parks, etc. MSW generally contains food wastes, paper, cardboard, plastics, textiles, glass, metals, wood, street sweepings, general wastes from parks, beaches, and other recreational areas.

Waste generation scenario

Catastrophic growth in population has led to massive urbanization, industrialization and agricultural advancement which has resulted in economic growth on one hand and increased municipal solid waste generation on the other. India generates approximately 133760 tonnes of municipal solid waste per day and per capita waste generation ranges from approximately 0.17 kg per person per day in small towns to 0.62 kg per person per day in cities (Kumar *et al.,* 2017). Municipal solid waste in India contains approximate 40–60% compostable, 30–50% inert waste and 10%-30% recyclable (Joshi and Ahmed*,* 2016). Biodegradable Waste generally includes food and kitchen waste, green waste (vegetables, flowers, leaves, fruits) and paper. India produces around 3000 million tonnes of organic wastes annually (Bhardwaj, 2010).

Why waste management?

Effective waste management is the major challenge as current systems in India cannot cope fully with the volumes of waste generated and it negatively impacts the environment and public health and also wastage of untapped nutrients in the form of waste. Unscientific disposal of solid wastes i.e. open dumping and landfilling in low lying areas outside the cities or rural areas reflect an ugly look and causes an adverse impact on human health, water pollution, methane emission and soil degradation which leads to loss of vegetation and decline in agricultural productivity that ultimately affect the ecology (Bundela *et al.,* 2010). For hygienic disposal of organic wastes it should be managed effectively. Hence, the practice of residue recycling gains importance and it can be achieved by composting and vermicomposting of farm, urban and agro-industrial waste. The recycling of organic wastes through composting methods is the key technology for production of organic manures which can be used as organic amendment for soils as it helps to build up of soil fertility thus greater productivity from agricultural land.

Analysis conducted by National Environmental Engineering Research Institute (2005) reveals that on an average domestic waste in India consists Nitrogen (0.64 ± 0.8)%, Phosphorus (0.67 ± 0.15)%, Potassium (0.68 ± 0.15)% with C:N ratio (26 ± 5)%. Several studies have shown that scientific utilization of organic solid wastes can provide nutrients for plant growth as well as improve soil health.

Waste management methods

There are various methods followed for waste management such as- composting, biomethanation, open dumping, thermal treatment (incineration, pyrolysis, gasification, and refuse derived fuel) and landfill. Composting generally is the aerobic microbial transformation of organic matter (Baca *et al.,* 1992), and has been designated as the most adequate method of managing organic wastes or organic fraction of urban solid waste (Tognetti *et al*., 2007). Traditional composting process includes a thermophilic phase (45 to 65° C) and takes more time for decomposition which results in losses of 55% organic matter and 30-50% of nitrogen (Tejada and Gonzalez, 2009). Among various methods of composting, one of the best options for treating domestic household waste is vermicomposting (Dalal, 2012). Vermicomposting and composting have been observed as a viable, cost-effective, and rapid technique for the efficient management of the organic solid wastes (Hand *et al*., 1988).

Vermicomposting

Vermicomposting is the process of conversion of biodegradable matter by earthworms into vermicast. It is considered as an eco-biotechnological and non-thermophilic process of composting that stabilize the organic wastes, involving the action of earthworms and associated microorganisms (Edwards and Burrows, 1988). Vermicomposting mainly provides a way to treat organic wastes more quickly. Earthworms are considered to be natural bioreactors which are able to proliferate along with other microorganisms and effectively lead to the biodegradation of wastes. In the process, a major fraction of the nutrients contained in the organic matter is converted to more bioavailable forms. Huge amount of organic waste materials with high nutrient content can be used as the substrates for vermicomposting and use of vermiculture technology for recycling of such untapped potential source of nutrients gives a valuable manure in a short period while under normal conditions it takes long time for decomposition. Vermicompost is finely divided peat-like materials with a vast surface area, high porosity, aeration, drainage, and water-holding capacity providing strong absorbability and retention of nutrients. Vermicompost is a reservoir of water-soluble nutrients and is an excellent nutrient-rich organic fertilizer and soil conditioner. It also generates products that have lower salinity levels that are therefore more beneficial to plant medium. Application of vermicompost boosts the crop growth and yield due to the presence of absorbable forms of plant nutrients and plant growth regulators.

As compared to composting, vermicomposting often produces a product with a lower mass, lower processing time, low phytotoxicity, and fertilizer value is usually greater (Lorimor *et al*., 2001). Several studies have shown that vermicomposting of municipal wastes can be a suitable option for production of useable products.

CONCLUSION

The disposal of ever increasing amount of organic municipal waste is becoming a serious problem in India. Thus, it is imperative to develop a proper technique for conversion of available organic waste in to valuable organic manure and use it further to meet the shortage of fertilizers and for improving soil fertility. Vermicomposting is considered as an appropriate technique for the disposal of such organic waste.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Microbes, its types and their role in organic agriculture

Article id: 22928

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Microbes Definition

An extremely small living thing that you can only see with special piece of equipment(a microscope) and can be multicellular or single-celled organisms.

Types of Microbes- bacteria, protozoa, some algae and fungi.

Bacteria: PSB, Rhizobium, Azatobactor, Azospirillium, pseudomonas sp., acetobactor, Bascillas sp.

Phosphorus solubilizing Bacteria: PSB are beneficial bacteria capable of solubilizing inorganic phosphorus from insoluble compounds. P- solubilization ability of rhizosphere microorganisms that increases P uptake by the plant and crop yield. Plants acquire phosphorus from soil solution as phosphate anion. It is the least mobile element in plant and soil contrary to other macronutrients. It precipitates in soil as orthophosphate or is adsorbed by Fe and Al oxides through legend exchange. Phosphorus solubilizing bacteria play role in phosphorus nutrition by enhancing its availability to plants through release from inorganic and organic soil P pools by solubilization and mineralization. Principal mechanism in soil for mineral phosphate solubilization is lowering of soil pH by microbial production of organic acids and mineralization of organic P by acid phosphatases. Use of phosphorus solubilizing bacteria as inoculants increases P uptake. These bacteria also increase prospects of using phosphatic rocks in crop production.Greater efficiency of P solubilizing bacteria has been shown through co-inoculation with other beneficial bacteria and mycorrhiza.

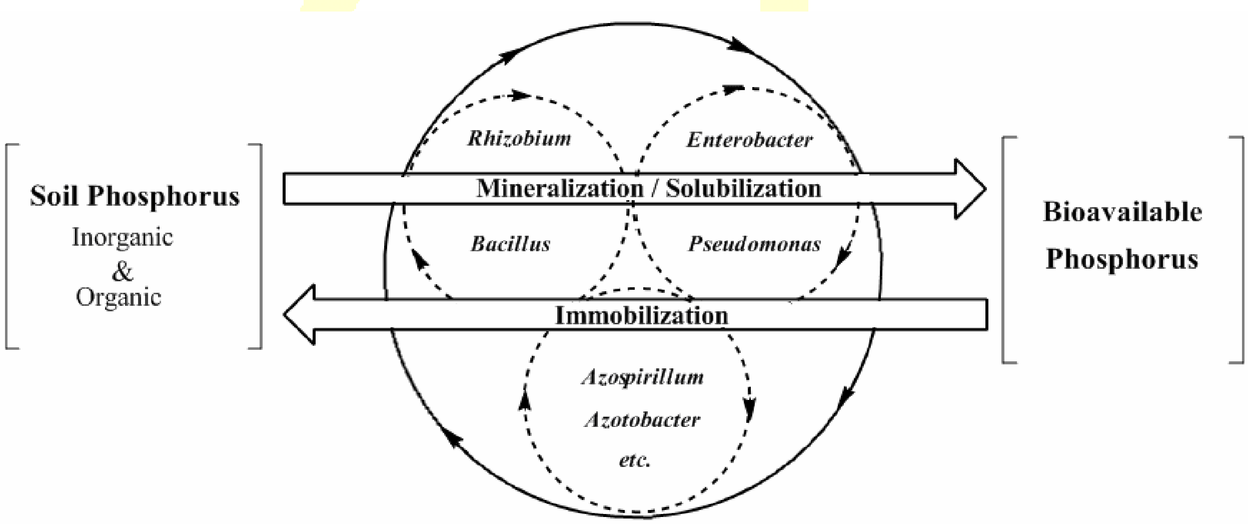

Figure 1: Schematic diagram of soil phosphorus mobilization and immobilization by bacteria

Rhizobium: Rhizobium is a genes of gram negative soil bacteria which symbiotically fixes atmospheric nitrogen after becoming established inside the root nodules of legume. These bacteria infect the roots of leguminous plants, leading to the formation of lumps or nodules where the nitrogen fixation takes place. About 90% of lugumes can become nodulated.

Rhizobium species	Crop group	Leguminous crops
1. *Rhizobium leguminosarum*	Pea	Peas, lathyrus, le-ntil
2. *R. japonicum*	Soyabean	Soyabean
3. *R. phaseoli*	Beans (Phaseolus)	Kidney and garden beans
4. *R. trifoli*	Clover	Clovers
5. *R. meliloti*	Alfalfa	Melilotus
6. *R. lupini*	Lupini	Lupines
7. Various	Cowpea miscellany	Cowpea (Vigina), Peanut (Arachis), Pigeon pea (Cajanus)

Azotobacterial: is a genus of free- living nitrogen fixing diastrophic bacteria whose resting stage is a cyst. It is primarily found in neutral to alkaline soils. In aquatic environments and on some plants. It has several metabolic capabilities, including atmospheric nitrogen fixation by conversion to ammonia. Azatobactor chrococcum is the most commonly occurring species in arable soilsof India. Apart from its ability to fix atmospheric nitrogen in soils, it can also synthesize growth promoting substances viz., auxins, gibberellins and to some extent the vitamins. Many strains of Azatobactor also exhibit fungicidal properties against certain harmful species of fungus. Response of Azatobactor has been seen in clustar bean, spinach, tomato, onion, carrot, celery, beets, garlic, etc.

Azospirillium: is gram negative, microaerophilic, non formative nitrogen fixing bacterial genes from the family rhodospirillaceae mainly present monocot plants mainly present surrounding of roots and recognize as dominant soil microbe. Fixes Nitrogen in the range of 20 to 40 kg per ha. in rhizosphere in the non legume plant such as cereals, millets, oilseeds, vegetables as garlic, Ginger, tomato, spinach, beet etc. considerable quantity of nitrogen fertilizer up to 25 to 30 can be save by using azospirillium inoculant these species have been commercially exploited for the use of nitrogen supply bio fertilizers.

Crop	Species
Alfa-alfa	*Pseudomonas surnigae*
Common bean	*Azospirillium brisilense*
Pea, Red clover	*P. floureneces*

Acetobacter: is an obligatory aerobic, nitrogen fixing bacteria that is known for producing acid as a result of metabolic processes. Acetobactor diazotrophicus and it carries out nitrogen fixation under aerobic conditions. It can be found symbiotic relationship with many different plants, such as sugarcane and coffee plants.

Bacillius spp.: microbes that are beneficial to plant are used to enhance crop yield and alternatives to chemical and pesticides.

Fungi : are multicellular eukaryotic organisms that are heterotroph and they have symbiotic association with plant and bacteria.

Trichroderma sp.: is a potent biocontrol agent and used extensively for soil born disease it has been used successfully against pathogenic fungi belonging to various genera, viz.

Trichoderma viridi : is an antagonistic fungal organism present naturally in the soil and is highly effective for the control of seed and soil borne diseases of majority of economical important crop including plantation crop. The biological control agent when applied, colonies the seed/ rhizosphere soil area of the crop and multiplies on the surface and killers not only the pathogen present on surface of the seed but also gives protection against soil borne pathogen until life of crop by action of myco-parasitism.

The effectivie control of wide range of soil borne disease like *rhizoctoni solani, microphomena phaseolina and fusarium spp.* Mixed it very important weapon against diseases such as root rot , seedling disease charcoal rot, wilt, damping off, collar rot etc.

Recommended crop: it is used as protecting crop such as cauliflower, cotton, banana, chili, potato. Citrus, pea, onion, turmeric, brinjal, betel vine and all vegetables crop . against soil borne disease.

Name of disease	Crop	Fungal pathogen	Species used
Wilt	Tomato, chili, potato, pecnut, black pepper coffee and litchi	*Fusarium sp.*	*T. viridi,* *T.virsens* *T. harzanium*
Root rot	Citus. Tobacco, pineapple, durian, rubber, black pepper and litchi	*Phytophthora spp.*	*T. viridi,* *T. harzanium*
Damping off	Tomato, chili, potato, pecnut, cabbage	*Pythium sp.* *Rhizoctona solani*	*T. hematum, T. viridi,* *T.virsens* *T. harzanium*
Stem rot	Tomato, chili, potato, pecnut,	*Selerotium rolfsii*	*T. hematum, T. viridi,* *T.virsens* *T. harzanium*
Blight	Tomota, potato	*R. Solani*	*T. viridi,* *T. harzanium*
Cottony rot	Cabbage, Chinese cabbage	*Sclerotinia selerotiorum*	*T. viridi,* *T. harzanium*

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

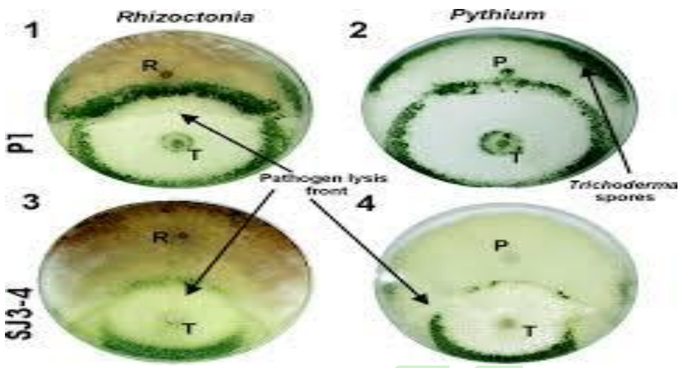

Fig 1. Pathogen control by trichoderma species

Advantages :

- Effective against seed borne diseses by eliminating the seed borne pathogen on the seed surface.
- Also give protection to the seeds and plants through elimination of pathogen in rhizosphere region
- Application of trichoderma formulation is safer to the environment thus promote organic agriculture.
- Easy to apply and safer to human and other beneficial organisms
- It can be combine with usage of other biofertilizers/ biopesticides.
- It will multiply fast in soil and overcome residual problem also.
- It give protection against the diseaes throughout the crop period.
- Less costly compare to chemical based plant disease management.
- It also promotes the plant growth by various mechanisms

Methods of applications:

- **Seed treatment :**

  Mix 5 gm of trichoderma formula in a small quantity of water and apply on 1 kg of seed. Dry the inoculated seed under shade for 30 minute over clean paper/ gunny bag and sow immediately.
- **Soil treatment :**

  Mix 2.5 kg of trichoderma formulation in 50 kg farm yard manure (FYM) or Gobar Khad and use this for preparation of one acre land.

Precaution:

- Do not used trichoderma along with chemical fungicides
- Should be used up to 6 months after preparation
- It should be store in well ventilated and clean ares.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Soil Water Erosion: A Serious Threat in Hilly Areas of India - Its Management is Need of Era

Article id: 22929

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INTRODUCTION

Soil erosion is a naturally occurring process that affects all landforms. In agriculture, soil erosion refers to the detachment and carrying away of soil particle to another place by the agencies of water, wind or gravitational force. It is the most destructive phenomena causing the loss of top fertile soil, degrading the environment and reducing the storage capacity of the water bodies. The soil loss from an area is a complex phenomena affected mainly by climate, parent material, slope and land use. The greatest losses of soil have been founded in bare soil followed by cultivated and least in the soil with natural vegetation. Within each land use, the highest rates are associated with semi-arid, semi-humid and tropical monsoon conditions. Sediments eroded from hillslope, through river system, get deposited in the foot slopes or in floodplains, where these can remain in temporary storage next storm to even millions of years as in colonial and alluvial materials. The loss of soil from agricultural and non-agricultural lands is a serious problem throughout the world.

Soil water erosion is the detachment and transportation of soil particle take place by the agent of water. Water erosion is a serious problem in India. Of the total degraded land in India, more than 80% is affected by soil erosion and out of it about 80% of it occurs by water. The annual water erosion rate values ranges from less than 5 t ha^{-1} yr^{-1} (for dense forests, snow-clad cold deserts, and the arid region of western Rajasthan) to more than 80 t ha^{-1} yr^{-1} in the Shivalik hills in northwest region with an average value of 16 t ha^{-1} yr^{-1}.

CAUSES OF WATER EROSION

Deforestation - Deforestation is the larger scale removal of trees to make room for something besides forest. This can include clearing the land for agriculture or grazing, or using the timber for fuel, construction or manufacturing and thus leads to large scale soil erosion by water.

Overgrazing - Overgrazing occurs when plants are exposed to intensive grazing for extended periods of time, or without sufficient recovery periods. It can be caused by either livestock in poorly managed agricultural or natural vegetation especially before the onset of rains. This coupled with high temperature destroy the natural vegetation and prepares the ground for large scale soil erosion with high intensity rains.

e-ISSN: 2581 - 8317
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Intense tillage – the intense tillage of soils results in decrease in soil organic carbon, breakdown of aggregates into smaller particles, eases the soil detachment and transportation and finally accelerates the rate of soil erosion by water.

Inappropriate cultivation practices – Cultivation practices viz. up and down cultivation, cultivating sloping lands, unsafe disposal of excess runoff water, etc. lead to the accelerated soil erosion by water.

TYPES OF WATER EROSION

Splash Erosion – splash erosion or raindrop impact represents the first stage in the erosion process. Rain drops behave as little bombs when falling on exposed or bare soil, dispersing the soil aggregates and displacing the detached soil particle. Splash erosion results in the formation of surface crusts which reduce infiltration resulting in increased runoff.

Sheet Erosion – Sheet erosion is the uniform removal of soil layer from the sloping lands. The top fertile soil layer is washed away from the arable lands. Since a uniform layer of soil is removed, this type of soil erosion mostly goes unnoticed by the farmers (Figure 1).

Figure 1 Sheet Erosion

Rill Erosion – Rill erosion is the most common form of soil erosion by water. Rill erosion is the removal of soil by concentrated water running through little streamlets, or head cuts. Detachment in a rill occurs if the sediment in the flow is below the amount the load can transport and if the flow exceeds the soil's resistance to detachment (Figure 2).

Figure 2 Rill Erosion

Gully Erosion – Gully erosion is an advance stage of rill erosion where surface channel have eroded to the point where these cannot be obliterated by tillage operation. Gully erosion is responsible for removing vast amount of soil irreversibly destroying farmlands, roads and bridges and deteriorating the water quality by increasing the sediments load in streams (Figure 3).

Figure 3 Gully Erosion

Management of Soil Erosion by using basic principle

- Covering the soil to protect it from rainfall.
- Increasing the infiltration capacity of the soil.
- Providing safe-ways for disposing of unavoidable runoff.
- Increasing surface roughness to reduce the velocity of runoff.
- Improving the aggregate stability of soil.
- Soil and water conservation measures should be practiced with a full consensus and participation of the farmers
- Land management practices such as agro-forestry, composting, soil fertility management and erosion prevention measures (terracing/contour bunding) should be practiced.
- Repair/renovation of already existing terraces and repairing of field boundaries.
- Construction of mechanical conservation structures should be followed up by other inputs, such as fertilizer, improved seeds, and other farming factors.
- Fencing of pastures should be done in order to avoid overgrazing. This would make grazing lands more productive by their judicious utilization through proper management.

CONCLUSION

Soil erosion is an important form of soil degradation which is taking a toll not only on soil fertility and productivity buts its off- site impacts are much more devastating especially from environmental degradation point of view. The offsite effects of soil water erosion viz. eutrophication of water bodies, loss in storage capacity of natural and manmade reservoirs, flash floods, land /mudslides etc. are a common scene during the present times leading to severe loss to the properties and human lives. The increasing population pressure has compelled us to change shifting land use from agriculture to urban lands and from forests to agriculture lands. This coupled with mans greed led to large scale deforestation, thus heralding the era of accelerated erosion. It is now a need of the hour that we adopt various preventive and management strategies to check this menace of soil erosion.

Preservation of Surgarcane Juice

Article id: 22930

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Sugar cane is a crucial commodity all over the world. Specific value-added products from sugar cane have been launched by a number of industries on a daily basis. Sugarcane juice, is a product of value to the agriculture and liquor industries. Preservation of juice is a major challenge for farmers and industries that have been subjected to different techniques to avoid its degradation and boost its consistency. The present overview includes the processing of sugar cane worldwide, its value-added products traditional and recent methods for retaining the quality of juice. Brazil is the top of the list for the world's largest sugarcane growers. The nation has the capacity to produce a total of 739.3 million metric tons of the product each year. Local sugar consumption in Brazil is also high due to the increasing popularity of the use of biofuels produced by sugar cane in various Brazilian industries. Ethanol fueled cars are also growing in popularity among Brazilians, increasing their demand across the region. In addition, sugar cane is grown in India, with the exception of cold hilly areas such as the Himachal Pradesh and Arunachal Pradesh Kashmir Valley. There are two distinct belts in the region, tropical and subtropical, which are distinguished by a marked difference in climatic and agricultural conditions. The tropical sugar cane belt comprises of Maharashtra, Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka and Kerala. The subtropical sugar cane belt comprises of Punjab, Orissa, Assam and West Bengal. Most parts of the cane lie in the subtropical belt on flat alluvial soils with an altitude of 9 m to 27 m above MSL (Minimum sea level).

Area Productions and Yield of Sugarcane in India

Sugar cane production in India has been increasing gradually over the last three decades. During the base year of the first five-year plan, the production of sugar cane in 1951-56 amounted to 57.1 million tons from an area of 1.7 million hectares. It rose to 152.3 million tons for an area of 2.6 million hectares between 1980 and 1981. This contributed to 295.7 million tons (4.1 million hectares) in the year 1998-1999. In fact a total yield of 178 million tons of cane from a region of 32 million hectares was produced in 1977-78 compared to the fourth program goal of 165 million tonnes. Sugarcane is grown in various countries in subtropical and tropical regions of the country.

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The major sugarcane growing states are:
a) Sub-tropical: Uttar Pradesh, Uttarakhand, Haryana, Punjab, Bihar with annual rainfall of 180 to 2000 mm. The area varies from warm, humid and dry sub-humid to cool arid, semi-arid and arid.
(b) Tropical region: Karnataka, Tamil Nadu, Maharashtra, Andhra Pradesh, Gujarat, Madhya Pradesh with annual rainfall of 602 to 3640 mm with humid to dry subhumid and semi-arid to dry semi-arid environments.

Value Added Products of Sugarcane

It has been estimated in Cuba that up to 31 products are produced from sugar cane. These include refined sugar, raw sugar, molasses, gin, rum, bagasse, tea, dextran, confectionary wax and glucose. An average 100 tons of sugar cane was provided by 14.3 t raw sugar, 27.2 t bagasse, 5.2 t filter cake, 2.6 t molasses and 50.7 t waste water.

Sugarcane juice

The total production of sugar cane in India is about 271 million tonnes. It is primarily grown for the processing of sweeteners such as sugar, jaggery and khandasari. A small portion of the sugar cane is also used for other purposes. Sugarcane juice is available almost all over the world. But the juice extracted from the canes turns dark brown and there is significant sedimentation during transport.

Sugarcane juice nutritional value

The juice Sugarcane per serving (28.35 grams) contain Energy-111.13 kJ (26.56 kcal), Carbohydrates-27.51 g, Protein-0.27 g, Calcium11.23 mg (1%), Iron 0.37 mg (3%), Potassium41.96 mg (1%), Sodium17.01 mg (1%) (Source: Nutrient Information from ESHA Research).

Health Benefits of Sugarcane

Sugar cane (*Saccharum officinarum*) originates in New Guinea. The plant belongs to the Gramineae tribe. Sugar cane is a C4 plant with a strong photosynthesis intensity (around 150-200 percent above the level for other plants). It's a perennial crop of high self-tolerance. Sugarcane juice is a common and refreshing drink in many parts of the world. Sugar cane juice is often used in folk medicine as a treatment for jaundice. Hygienic requirements are generally not established during shipment of the sugar cane from the field to the stage of extraction and preparation of the concentrate. The juice is being extracted using hand or power operated crusher which cannot be stored for a couple of hours due to its fast deteriorating quality. The juice is processed using a hand or power-operated crusher that can not be held for a few hours due to its rapidly deteriorating consistency. Sugarcane juice is used to treat a number of human illnesses in different parts of the world. Sugar cane juice is quite healthy because it includes natural sugars, minerals such as iron magnesium, phosphorous, calcium and organic acids such as malic acid, succinic acid, acotinic acid, etc. Preservation is achieved when the juice is stored for a longer period of time without any decay or harm from direct contact with the environment. Sugarcane juice is good for the prevention of urinary related diseases. This allows the supply of urine clear and enables the kidneys to perform better. Sugarcane juice relieves the burning sensation caused by urinary tract infections. Sugar cane juice supplies glucose, which is stored as glycogen to be' burned' by muscles when needed. It has been used in Ayurveda and Unani medicine systems in India since time immemorial either as a single drug or in conjunction with other plant products. Sugarcane extracts have been identified with a wide range of biological effects, such as immune activation anti-thrombosis activity, anti-inflammatory activity, adjuvant vaccination, acetylcholine release control and anti-stress effects. Sugarcane juice has a strong biological effect on the increase in innate immunity to pathogens. Patients of jaundice and individuals with liver-related disorders have been advised to drink sugarcane extract in the conventional healing medicine program.

Preservation of Sugarcane Juice

Conventional heat treatment gives the taste of jaggery and the delicate quality of the juice is adversely affected. Sugarcane variation and production methods often influence the characteristics of the juice In fact, polyphenol oxidase is the main enzyme implicated in the discoloration of sugar cane juice, which can be strengthened by heat inactivation of the enzyme. The application of citric acid or ascorbic acid to the juice often gave the juice a nice, bland orange colour. The introduction of lemon and ginger followed by pasteurization and preservation with sulfur dioxide often decreased physico-chemical changes during preparation of ready-to-serve bottled sugar cane juice. Preserving raw sugar cane juice is a difficult problem. Sugarcane juice will turn brown shortly after it has been processed and will be tainted by fermentation within hours. Researchers reported that, a mixture of gamma radiation (5 kGy) with allowable preservatives and low temperature storage (10 ° C) could retain raw sugar cane juice for more than a month. The preservatives used were citric acid (0.3%), sodium benzoate (0.015 percent), potassium sorbate (0.025 percent) and sucrose (10 percent). The procedure continued to increase the shelf life to 15 days at room temperature (26 ± 2 ° C) and 35 d at 10 ° C. Within this time period, the microbial load was observed to be below the measurable level.

AGRICULTURE & FOOD: e- Newsletter
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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Nutritional Importance of Pearl Millet

Article id: 22931

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INTRODUCTION

Pearl millet is the most widely grown type of millet. It has been grown in Africa and the Indian subcontinent since prehistoric times. In different pearl millet genotypes the starch content of the grain varied about 62.8 to 70.5%, soluble sugar 1.2 to 2.6% and amylose 21.9 to 28.8% (Jambunathan and Subramanian, 1988). Lower values for starch (56.3 to 63.7%) and amylose (18.3 to 24.6%) have been found in some high-yielding Indian pearl millet varieties (Singh and Popli, 1973). Jambunathan and Subramanian found that the predominant component of total soluble sugar (2.16 to 2.78%) was sucrose (66%), followed by raffinose (28%). Other sugars detected in measurable amounts were stachyose, glucose and fructose. The proportion of sucrose in total sugar was lower in pearl millet than in sorghum.

Pearl millet, like sorghum, is generally 9 to 13% protein, but large variations in protein content, from 6 to 21%, have been observed. Lysine is the first limiting amino acid of pearl millet protein. A significant inverse correlation has been reported between the level of protein in the grain and the Lysine content of the protein. In high-protein varieties of pearl millet with protein content ranging from 14.4 to 27.1%, significant inverse correlations have also been observed between protein and threonine, methionine and tryptophan. The essential amino acid profile shows more lysine, threonine, methionine and cystine in pearl millet protein than in proteins of sorghum and other millets. Its tryptophan content is also higher.

Differences in lipid extraction procedures as well as genetic variability were shown to contribute differences in the fatty acid content of pearl millet. The principal fatty acids in both free and bound were found to be linoleic, oleic and palmitic acids. Distinct differences in fatty acid composition were noted in the neutral lipid, phospholipid and glycolipid fractions. Neutral lipid was highest in linoleic acid and lowest in palmitic acid; phospholipid was lowest in oleic acid and highest in palmitic acid; and glycolipid was highest in linolenic acid.

The total dietary fibre in pearl millet (20.4%) and finger millet (18.6%) was higher than that in sorghum (14.2%), wheat (17.2%) and rice (8.3%) also found that the total dietary fibre content of pearl millet was 17% (Kamath and Belavady, 1980).

Nutritional Facts of Pearl Millet

Due to its rich composition of minerals and proteins, Pearl Millet has many health benefits. Pearl Millet has the highest protein content. It contains many essential minerals like magnesium, phosphorus, zinc etc. It contains essential amino acids and vitamins also which contribute to its therapeutic properties.

• **Beneficial in treating stomach ulcers:** Pearl millet is recommended for curing stomach ulcers. The most common cause for stomach ulcers is excess acidity in the stomach after food intake. Pearl millet is one of the very few foods that turns the stomach alkaline and prevents formation of stomach ulcers or reduces the effect of ulcers

• **Beneficial for Heart health:** The lignin and phytonutrients in millet act as strong antioxidants thus preventing heart related diseases. Therefore, pearl millet is considered good for heart health. High amounts of magnesium present in pearl millet have been shown to control blood pressure and relieve heart stress

• **Beneficial due to high amount of magnesium:** Pearl millet contains high concentration of magnesium which helps reduce severity of respiratory problems for asthma patients and is also effective in reducing migraine attacks

• **Helps in bone growth development and repair:** Pearl millet has a large amount of phosphorus. Phosphorus is very essential for bone growth and development as well as for development of ATP which is the energy currency of our body

• **Reduces cancer risk:** All millets are known to reduce the risk of cancer occurrence and pearl millet is no exception. Though scientists are not sure how this is, they believe it has something to do with the high amount of magnesium and the compound phytate.

• **Helps in weight loss:** The biggest challenge faced by people trying to lose weight is controlling their food intake. Pearl millet can aid the process of weight loss as it is high in fibre content. Owing to its fibre content it takes longer for the grain to move from the stomach to the intestines. This way, pearl millet satiates hunger for a long period of time and thus helps in lowering the overall consumption of food

• **Beneficial for diabetes:** Pearl millet is very effective for controlling diabetes. Because of its high fibre content, it digests slowly and releases glucose into the blood at a slower rate as compared to other foods. This effectively helps in maintaining the blood sugar level constant in diabetes patients for a long period of time

• **Beneficial for Celiac Disease:** Celiac disease is a condition in which a person cannot tolerate even a small amount of gluten in his/her diet. Unfortunately, most of the common grains like rice, wheat, etc. have gluten present in them. Millets are the only type of grains which do not have any gluten present. Thus this is suitable for people with celiac disease

• **Reduces Cholesterol:** It is common knowledge that Pearl Millet is suggested for people suffering from high cholesterol levels. Pearl millet contains a type of phytochemical called phytic acid which is believed to increase cholesterol metabolism and stabilise the levels of cholesterol in the body

• **Contains all the essential amino acids:** Amino acids are essential for smooth functioning of our body. Pearl millet is one of the few foods which have all the essential amino acids required in it. Unfortunately, most of these amino acids are lost in the process of cooking because these amino acids cannot stand high temperatures. Thus it is better to consume in a low cooked form so as to preserve as many of these amino acids as possible

• **Beneficial in Preventing Gall stones:** The high fibre content in pearl millet is also known to reduce the risk of gall stone occurrence. The insoluble fibre content in pearl millet reduces the production of excessive bile in our system. Excessive amount of bile secretion in our intestine often leads to aggravate the condition of gall stones

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

• **Anti-allergic properties:** Pearl millet is a treasure trove of beneficial properties. The grain is very digestible as such and has a very low probability of causing allergic reactions. Due to its hypo allergic property, it can be safely included in the diets of infants, lactating mothers, elderly and convalescents.

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BIOFORTIFICATION - a way to nutritional security in India

Article id: 22932

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Globally, around two billion people suffer from malnutrition, whereas 815 million people are undernourished. Among children (<5 years), 155 million are stunted and 52 million do not weigh enough according to height enough according to height (wasting). Nearly 45% of deaths among children under age of five years are linked to malnutrition. The problem is so widespread that 88% of the countries experience two or three forms of malnutrition. The various strategies for tackling malnutrition are discussed here.

Food-fortification: it is a process where food is enriched with specific nutrients through physical addition. One of the beat examples is iodized salt, where required quantity of iodine (I) is consumed along with the salt.

Medical supplementation: it is a process where specific nutrients is directly provided to population in the form of pills or capsules. One of the best examples is vitamin-A pills that are distributed in the targeted area to address the vision related problem especially among children. Supplementation of iron (Fe) tablets to the pregnant women is also widely used worldwide.

Dietary- diversification: it is a process where type of food consumption being practiced at the house-hold is changed. Cereal-based diet is the main stay of food among the resource poor. Inclusion of pulse, fruits and vegetables and even animal-proteins in the diet makes the food more balanced.

Biofortification: it is process where the concentration of nutrients in the edible parts of the crop is increased through genetic means like breeding or transgenic approaches. Natural variants of the target genes in the gene pool that specifically enhances the accumulation of a specific nutrient can be introgressed into an elite genetic background through breeding approach. Development of quality protein maize (QPM) with high lysine and tryptophan in endosperm protein is an example. In case the variation for the target trait is not available in the gene pool, then genes from cross incompatible or organism is used through genetic engineering. Golden rice with high concentration of provitamin-A is a classical example of crop biofortification achieved through transgenic approach.

Among the above four avenues, food fortification, medical supplementation and dietary diversification in general have not been found viable in the long run due to various reasons. Lack of purchasing power of the poor due to poverty, restricts the access to the fortified foods, thereby reducing their efficiency and application. Poor infrastructure in developing countries has limited the widespread use of medical-supplementation. Dietary diversification is often limited by crop seasonality, expense and lack of purchasing power by the poor. Biofortification on the other hand is regarded as the most sustainable and cost effective approach, and nutrients reach the human body in pure form.

Importance of nutrition: among various nutrients, protein, lysine, tryptophan, iron, zinc, vitamin A and vitamin C are essential for human nutrition, and their deficiency leads various symptoms and health disorders. While protein is a macronutrients due to their minute requirement. On the other hand, ericic acid, glucosinolate and Kunitz Trysin inhibitor are the anti-nutritional factors as consumption in higher level effects adversely on human beings and livestock health.

Development of biofortified cultivars: Indian Council of Agriculture Research is the flagship organization for agriculture research in the country. ICAR has contributed immensely to make India self sufficient in food production. From 50.82 million tonne of food production in 1950-51, India has touched 284.8 million tonne during 2017-18 (Fourth Advance Estimates). Similarly, horticultural crops also experienced increase from 96.56 million tonne during 1991-92 to 306.8 million tonne during 2017-18 (Third Advance Estimates). The tremendous gain achieved in yield potential has been possible due to the development of high yielding varieties and heterotic hybrids across crops. These high yielding cultivars generally possess low concentration of essential nutrients, thus warrants targeted approach. Nutritional status of different essential nutrients in popular varieties of different crops is : Rice 7.0-8.0 % protein and 12.0-16.0 ppm zinc in polished grain; wheat 32.0 ppm zinc and 28.0-32.0 ppm iron; Maize 1-2 ppm provitamin-A, 1.5-2.5% lysine and 0.3-0.4% tryptophan; Pearl Millet 45.0-5000 ppm iron and 30.0-35.0 ppm zinc; Lentil 55.0 ppm iron; Mustard >40.0 % erucic acid and >120.0 ppm glucosinolates; Soyabean - presence of KTI; cauliflower negligible α-carotene and negligible anthocyanin and pomegranate 2.7-3.2 mg/100g iron, 0.50-0.54 mh/100g zinc and 14.2-14.6 mg/100g vitamin C. Research efforts at ICAR institute as well as SAUshave now led to the release of a series of biofortified varieties through All India Coordinated Research Projects which not only provide enough calories, but also deliver essential nutrients needed for adequate growth and development.

CHALLENGES

There are some operational challenges in adoption of nutritionally rich cultivars of various crops viz,

i. Wrong preparation of low yielding potential of biofortified varieties among the farmers,
ii. Most of the nutritional traits are phenotypically invisible (protein, lysine, tryptophan, iron, zinc and vitamin-C) and is difficult to convince the farmers and traders regarding the extent of quality of the produce,
iii. Quality maintenance is an issue as some of the nutritional traits (lysine and tryptophan) are governed by recessive genes and contamination by foreign pollen grains from neighboring fields dilutes the quality of the produce in the cross-pollinated crops,
iv. Enrichment of nutrients such as provitamin-A and anthocyanin leads to altered appearance of the produce (yellow vs. white maize, amd normal vs. yellow/purple sweet

potato), hence consumers at the village level, generally hesitate in accepting the biofortified produce as food,

v. Lack of awareness on health benefits of the biofortified varieties,
vi. Lack of profitable markets for commercial producers,
vii. Unwillingness among food processors in marketing biofortified produce as a premium products,
viii. No provision of premium on minimum support price or biofortiified produce across crops and
ix. In case of maize, weak linkage between farmers and local poultry.

The way forward

Intensive efforts by public sector institutions and policy for intense promotional campaigns can effectively ensure significant increase in adoption and acceptance of biofortified crop varieties. Strengthening the seed chain to produce and supply good quality seed is one the important steps for the popularizing biofortified varieties. Maintenance of genetic purity is very essential for keeping the quality traits intact, hence, special seed production areas need to be identified. Seed village programme can also be one option for taking the seed/commercial production of such varieties to avoid outcrossing from other conventional varieties. Providing subsidized seeds and other inputs would further contribution to the rapid dissemination of nutritionally improved cultivars among the farmers. Assured premium remunerative price through minimum support price for biofortified grains in the market will encourage the farmers to grow more biofortified crops. Investment on extension activity would make the farmers, industry and consumers aware of the availability and benefits of biofortified crops.

Recently unveiled national nutrition strategy-2017 by *NITI Aayog*, Government of India envisages alleviation of malnutrition in the country through food based solution. Inclusion of these Government sponsored programme like National Food Security Mission, *Rashtriya Krishi Vikas yojna* as well as nutrition intervention programmes of various ministeries of Government of India such as Integrated child Development Services scheme, Anganwadi scheme, Public Distribution System, 'Mid-Day Meal' scheme in schools and Nutrition Education And Training Trough Community Food and Nutrition Extension Units would help in providing the much needed balanced food to poor people. Central government has recently declared millets, finger millet, foxtail millet, proso millet, kodo millet, barnyard millet, little millet and two pseudo millets (buckwheat and ameranthus) as *Nutri-Cereals* because of their high nutritive value. This would boost their demand and allow farmers to get higher prices. Inclusion of biofortified products in these government sponsored schemes would specially benefit the children, pregnant women and elderly people, and would help in their quick dissemination.

SUMMARY

ICAR is committed to meet the sustainable development goals and achieve country's slogan of *'Kuposhan mukt Bharat'* (Malnutrition Free India). Development of biofortified crops with enhanced micronutrients was a major focus area of ICAR. To further expedite the process of development of biofortified crops, ICAR has funded a consortia research platform on 'Biofortification in Selected Crops for Nutritional Security', where rice, wheat, maize, pearl millet, sorghum and minor millets were targeted for nutritional enrichment. These high yielding biofortified crops besides serving as an important source for livelihood to poor people, assume great significance in nutritional security. Further extension division of ICAR has launched two very important projects viz., nutrisensitive Agriculture Resources and Innovation and Value Addition and Technology Incubation Centres in Agriculture through Krishi Vigyan kendras which will definitely help in popularization and promotion of the biofortified crop varieties and their products. KVKs are already working on Agri-Nutri Smart Village (A2N) model which focuses on nutria Education, Agri-Nutri Capacity Building and SHG-Farmer Nutri Clubs.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Bougainvillea: A Plant for Health and Happiness

Article id: 22933

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INTRODUCTION

Bougainvillea is a genus of thorny ornamental vines, bushes, or trees. The inflorescence consists of large colourful sepal like bracts which surround three simple waxy flowers. It is native to South America from Brazil west to Peru and south to southern Argentina.

Bougainvilleas are among the most popular ornamental shrubs in tropical, subtropical, coastal, and the Mediterranean climates around the world. It's an ever blooming perennial that bears flowers in colors like pink, red, rose, magenta, yellow, white, and orange. Moreover, new cultivars are coming with variegated foliage and a combination of two-three flower colors. Bougainvilleas are available in shrub form, semi-dwarf and dwarf cultivars for containers and flower beds. There are climbing varieties that can cover your ugly walls and entrance beautifully and there're thornless species too. They are extremely low maintenance, celebrate heat, and tolerate scarcity of water.

Landscape use of Bougainvillea

Bougainvilleas are popular ornamental plants in most areas with warm climates. Bougainvillea can be used as a houseplant or hanging basket in cooler climates. In the landscape, it makes an excellent hot season plant, and its drought tolerance makes it ideal for warm climates year-round. It can be pruned into a standard, but is also grown along fence lines, on walls, in containers and hanging baskets, and as a hedge or an accent plant. Its long arching thorny branches bear heart-shaped leaves and masses of papery bracts in different colours.

Climber

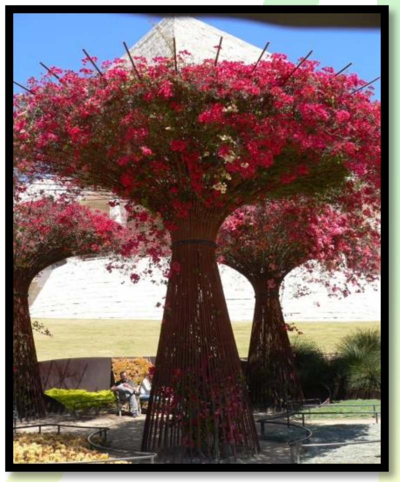
Specimen plant

Hedge

Group planting

Shrub

Topiary



Standard

Pot Plant

When we impose a geometric order on the landscape, we inhabit the landscape with human thought. When they do, they are referring to the prominent, permanent elements that give form and structure to their landscapes which give the site a character. Bougainvillea are in great demand by soft landscape architects for development of home gardens, factory gardens, municipal gardens, multinational companies, indoor and outdoor landscape, slope of river bank, sides of railway track, railway station, airport surroundings and historical monuments. Bougainvillea can be grown as shrubs in the garden along a boundary wall or in front of ugly pot, as bush specimen in a corner of the lawn, developed into a compact thorny impenetrable flowering hedge, as ground on slopes and mound in the garden. They look very attractive when developed and trained as a standard. Its use as an attractive pot plant is universally known. Bougainvillea has also been grown in hanging basket and a basket with flowering bougainvillea in their colourful splendour is a treat for the eyes.

Health Benefits of Bougainvillea

Bougainvillea is edible flower which is frequently used in most of the parts of the world for the preparation of salads and flower teas. The floral bracts are the rich source of betalain pigments particularly betacyanin which can be used as a natural colorant in food industries.

Every part of bougainvillea may be used medicinally, from the stems, leaves, bracts to flowers themselves. The leaves are employed by traditional healers for their anti-inflammatory properties. The flowers and bracts may be steeped in boiling water and consumed as tea that offers health benefits.

Bougainvillea possess certain medicinal properties because of the presence of a few substances in the plant. Some of them are alkaloids that offer marked physiological effects on humans. Some of the health benefits of bougainvillea are-

1. It helps ease cough- bougainvillea is used for cough relief, especially in South America. The flowers and bracts are allowed to steep in boiling water for several minutes, and then consumed to promote breathing.
2. It alleviates sore throat- The tea prepared from bougainvillea flowers and bracts may also be consumed in sore throat. The anti-inflammatory and antibacterial properties of the drink can help to attain immediate relief.
3. It may be used for indigestion- In South America a lot of people suffering from acid reflux consume tea of bougainvillea flowers and leaves to put their uncomfortable tummy issue to an end.
4. It is very good for ulcers- Consuming tea of bougainvillea floers and bracts is effective for stomach ulcers. The anti-inflammatory properties of the beverage can help soothe the ulcerations.
5. It helps put diarrhoea to an end- there is another great benefit of bougainvillea and that is managing diarrhoea.
6. It may be beneficial for diabetics- Another traditional medicinal use of bougainvillea is for controlling diabetes. It is said that bougainvillea leaf extracts help keep the levels of sugar in blood from spiking, which is highly beneficial for those with diabetes.
7. It is also used for hepatitis- bougainvillea is employed for treating hepatitis.
8. It helps raise the blood pressure- hypotension or abnormally low blood pressure can be managed with the help of bougainvillea. Those with hypertension or high blood pressure should stay away from consuming bougainvillea flower and bract tea.
9. It alleviates joint pain- Poultice out of the various parts of bougainvillea may be placed on painful and swollen joints. This is because bougainvillea is known to possess anti-inflammatory properties.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Cabbage crop Diseases and their Management

Article id: 22934

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Different diseases of Cabbage:

- **Black rot**
- **Downy mildew**
- **Leaf spot and Blight**
- **Fusarium wilt**
- **Clubroot of cabbage**
- **Sclerotinia rot/ White Mould**

Black Rot (***Xanthomonas campestris* pv. *campestris*)**:

This bacterial disease is common in areas having a warm and wet climate. Plants can be infected during any growth stage and the symptoms resemble nutritional deficiencies. Infected seedlings become yellow, drop lower leaves, and may die. Leaves may be affected on only one side of a seedling. The classic symptom of black rot is caused by local infection that results when bacteria enter leaves through natural openings of leaf margins. The infected tissue turns pale green-yellow and then turns brown and dies. Affected areas are usually wedge- or V-shaped. These areas enlarge as the disease progresses, and severely affected leaves may drop off.

Control:

- Use of black rot tolerant varieties is the best method to control the disease.
- Before sowing seeds are treated with Agrimycin-100 (100ppm) or Streptocycline (100 ppm).
- Planting should be done on raised beds to facilitate drainage.
- To avoid continuously growing in the same field.
- Disease infected plants should be removed and destroyed.

Downy Mildew *(Perenospora parasitica*):

The disease is very serious in nursery and it can also appear in field planting. High humidity, fog, drizzling rains, and heavy dew favour the disease development and spread. The first symptom observed are small, light green-yellow lesions on the upper leaf surface, later showing on the undersurface. The spots turn yellow as they enlarge. During periods of high humidity, a grayish white moldy growth is developed on the undersurface of the leaf.

Control:

- The crop should be irrigated judiciously to avoid periods of high humidity.
- Spraying the seedlings in the nursery beds with Copper Oxychloride (0.3%).
- Controlling the disease in the field, the crop is sprayed with Copper Oxychloride (0.5%).

Leaf Spot and Blight (*Alternaria brassicae* and *A. brassiciola*):

It is a destructive disease on seed crop. Older leaves are more susceptible. The initial symptoms are in the form of small dark yellow spots on the leaf surface. Later on the spots enlarge to circular areas with concentric rings and possibly surrounded by yellow halos. In severe cases, the entire plant defoliates.

Control:

- Use of disease free seeds, practicing proper crop rotation and seed treatment with hot water (50^{O}C for 30 minutes) helps to minimize the disease incidence.
- Spraying at the time of pod set and pre- harvest stage with Captan (0.2%) or Copper Oxychloride (0.5%) for the control of disease.

Fusarium Wilt ***(Fusarium oxysporum*** **f. sp *conglutinans*):**

Symptoms appeared 2 to 4 weeks after transplanting. Disease development is promoted by warm weather conditions. Initial symptom is the development of yellowish green colour on one side of the plant. A lateral warping or curling of the stem and leaves occurs. The lower part of the leaf blade adjoining the petiole or midrib wilts and dies. The lower leaves turn yellow and later the upper leaves are affected. The progress of disease in the plant depends upon the degree of varietal susceptibility and the soil temperature.


Control:

Disease control with the help of crop rotation, seed treatment, fungicide sprays.
The use of resistant varieties is the only control.
However, as a preventive measure the vulnerable stage of the young seedlings to the infection can be avoided by very early sowing of cabbage.

Clubroot of Cabbage (*Plasmodiophora brassicae)*:

Cool, wet and acidic soils is most favourable to the development and spread of the disease. Roots develop clubs (swellings) that can be 12-15cm wide. Affected seedlings do not show any root swellings until about 3 weeks after infection. Infection in the nursery stage results in the death of seedlings. Finally leaves become stunted, yellowish and prematurely bolt in hot weather.

Control:

- Early infection of seedlings can be destructive, so it is important to use only uninfected seedbeds and clean equipment.
- When susceptible varieties are grown in acidic soils, finely ground limestone is thoroughly mixed into the soil six weeks before planting to raise the soil pH above 7.0. Lime inhibits disease development, but will not prevent a disease outbreak if the spore load in the soil is sufficiently high. The quantity of lime is determined by initially measuring the pH of the soil.

Sclerotinia rot/ White Mould (*Sclerotinia sclerotiorum*):

This fungus can cause serious losses in the field, in storage, and under transit and market conditions. Generally, damp weather favours the occurrence of the disease. Infections may occur on the stem at the ground level, on the leaves at their bases, or where the foliage comes in contact with the soil. The fungus eventually colonizes the entire cabbage head and produces large, black, seedlike structures called sclerotia on the diseased tissue.

Control:

- The disease can be managed most successfully by combining cultural practices that discourage disease development.
- Rows should be planted in the direction of the prevailing winds to promote free flow of air movement within the plants.
- Cabbage and other susceptible crops (cauliflower, beans, peas, etc.) should not be planted in fields.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Ecological approach for the management of Insect Pests of Wheat

Article id: 22935

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INTRODUCTION

Wheat (*Triticum aestivum* L.) belonging to the family Graminaeae is one of the most important cereal crops of India. Wheat can though be cultivated in a variety of climate and soil types however, dry to sub humid areas with 250-750 mm annual rainfall are most suitable. Although the optimum growing temperature of wheat is 25°C it can also be cultivated in areas where minimum and maximum temperatures during the growing period ranges from 3° to 4°C and 30° to 32°C, respectively. The global production and productivity of wheat is 749 million tonnes. The main wheat producing regions in world are China, India, United States, Russian Federation, France, Australia, Germany, Canada, Turkey, Pakistan and United Kingdom.

The largest producer of wheat in world is China followed by India. In India, wheat covers an area of 30.23 million hectare, with 93.50 million tonne production and 3093 kg/ha productivity. The major wheat producing states in India are Uttar Pradesh (26.9 million tonne), Punjab (16.11 million tonne) and Haryana (11.14 million tonne). Punjab, Haryana, Uttar Pradesh, Bihar and Rajasthan are the major wheat producing states in India.

Wheat is the staple food for two billion people i.e., 36% of the world population. China (1.41 billion) is the most populated country in the world followed by India (1.34 billion). India is expected to surpass China by the year 2022 in terms of number of individual residing in the country, with its population reaching 1.7 billion by 2050. The production of wheat is 93.50 million tonnes in 2015-2016. With a population growth rate of 1.2%, the production of wheat must increase at the rate of 1.8 percent per year to meet the demand of increasing population.

However, the surplus production of wheat is hampered by a number of insect pest infestations. It is attacked by two dozen of insect pests from seedling stage to crop maturity. Gujhia weevil, cutworms, armyworms, aphids, thrips, termites and stem borers are the major insect pests of wheat. The insect pest cause heavy crop loss, it has been reported that 50 aphids per earhead can lead to 47.7% reduction in crop yield.

Nature of damage of insect pests of wheat

Aphids: aphids are the most destructive to the wheat crop. The crop is attacked by more than eleven aphid species, however *Microsiphum miscanthi*, *Rhopalosiphum padi*, *R. maidis* and *Sitobion avenae* are the most important ones. Aphid attack is seen from the seedling stage of the crop. They suck the sap from the crop rendering yellow colour to the attacked plant. Cloudy weather favours the aphid infestation.

Termites: the worker caste of termite (*Microtermus obesi* and *Odontotermus obesus*) attacks the crop mostly at the seedling stage but may also attack the mature crop. They feed on the roots, stem of the standing plants thereby the entire plant may dry up and can easily be pulled out. The workers feed in a semicircular fashion on leaf margins of wheat crop. They also feed on the cellulose content of the dead plant tissues. Application of the undecomposed farm yard manure and lack of irrigation favour the attack of termites

Borers: Pink stem borer bores (*Sesamia inferens*) the central shoot of the wheat crop resulting in the drying up of the growing points and development of dead heart. Severe attack by this pest causes the stem to break easily. The larval stage of american pod borer (*Helicoverpa armigera*) attacks the leaves at initial stages later they attack the earhead thus, the quality of the wheat is severely affected.

Armyworm: *Mythimna separate* survives on the rice stubbles during the summer season. The caterpillar is a defoliator which feeds on the leaves from edges to midrib while it may also feed on the head of the plant. The larvae generally feed during dawn and dusk period and hide in cracks of soil. Recently, this pest has assumed the serious pest status in the Northern India under Rice-Wheat rotation.

Brown mite: The nymphs and adult of brown wheat mite (*Petrobia latens*) suck the sap from the leaves causing a silvery flecking on the leaves. Under severe conditions the leaves may become reddish or bronze in colour. The leaves ultimately wither and dry up.

Need for an Ecological approach

The heavy dependence of farmers on synthetic chemicals such as dimethoate, primicarb, fenvelarate, thiamethoam, clothianidin to control the insect pests of wheat leads to problems such as disturbances in the environment, pest resurgence, pest resistance to pesticide, secondary pest outbreak, ill effects on non-target organisms, increasing application cost, and pesticide residue in food grains. All this necessitate the development of an alternate environmental friendly pest management strategies. This strategy is based on understanding the pest ecology avoids the large scale use of synthetic chemical protectants to lower the pest population number to economic threshold level. The goal of this practice is to lay emphasis on the proactive measures so as to redesign the agricultural ecosystem to the disadvantage to the pest and to the advantage of natural enemies (parasite and predators). Ecofriendly pest management ensures safe food for human consumption.

This approach avoids the use of pesticides, growth regulators, synthetic chemicals and relies on crop rotations, crop residues, green manures, biofertilizers, biopesticides and cow based liquid organic manure such as cow urine and cow dung. Organic growers spray panchgavya @ 3%. Neem derived insecticides such as neem oil, neem cake are comparatively less toxic than conventional pesticides and safer for parasite, predators and parasitoids. Aqueous leaf extract of Indian aconite *(Aconitum ferox* Wall.) found in Kumaon hills and alpine Himalayas is also highly toxic to the aphid population. Use of resistant varieties (HS 420, HS 277 are the rust resistant varieties suitable for the North Hill Zone, Raj MR 1 and C-306 are the cyst nematode and brown mite resistant variety) of wheat is also an environment friendly strategy

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

to manage a number of pest population prevailing in wheat agroecosystem. Ecological engineering is also being done by growing attractant, repellent, trap and barrier crops around the field bunds.

CONCLUSION

The population is increasing at an alarming rate. The more the population the more are the mouths to be fed which demands the high production of wheat. Severe insect pest infestation serves as a prominent constraint in its production. Therefore, frequent intervention is required to manage the insect pest population in wheat crop. The deleterious impact of agrochemical necessitates the need to use ecofriendly pest management approach which manages the insect pest population in a sustainable manner.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Effect of Agriculture on Environment

Article id: 22936

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Human influence on the land is accelerating because of rapid population growth and increasing food requirements. Human population growth together with competitive land use causes land scarcity, conversion of wild lands to agriculture and other uses. During the past three centuries, in many developing countries, growing demand for food due to an increasing population has caused substantial expansion of cropland, accompanied by shrinking primary forests and grassland areas. In the twentieth century, the world population grew four times. The world's cultivated area has grown by 12% over the past 50 years. Humans have altered land cover for centuries, but recent rates of change are higher than ever. In India, between 1880 and 2010, cropland area has increased (from 92 to 140.1 million ha), and forestland decreased (from 89 to 63 million ha). Agricultural intensification defined as higher levels of inputs like Irrigation, fertilizer and pesticides application that leads to soil, water and air pollution, which negatively affect environment and these high level of inputs transform to increased output of products per unit area and time. Tropical Asia increased its food production mainly by increasing its inputs like fertilizer, pesticide use and irrigation application. The increasing agricultural intensity generates pressure not only on land resources but also across the whole environment. Land cover and land-use patterns on Earth reflect the interaction of human activities and the natural environment. Land-use change reflected in land-cover change and land-cover change is a main component of global environmental change, affecting climate, biodiversity, and ecosystem services, which in turn affect land-use decision. Changing land-use practices have enabled world grain harvests to double from 1.2 to 2.5 billion tons per year between 1970 and 2010. The exponential population increase in recent decades has increased the practice of agricultural land conversion to meet the demand for food, which in turn has increased the effects on the environment.

Environment impact of Agriculture: There is several effect of agriculture intensification on environment; some of these are described below:

1) Climate change: Agriculture has been shown to produce significant effects on climate change, primarily through the production and release of greenhouse gases such as carbon dioxide, methane, and nitrous oxide. In addition, agriculture that practices tillage, fertilization, and pesticide application also releases ammonia, nitrate, phosphorus, and many other pesticides that affect air, water, and soil quality, as well as biodiversity. Agriculture also alters the Earth's land cover, which can change its ability to absorb or reflect heat and light, thus contributing to radiative forcing. Land use change such as deforestation and desertification, together with use of fossil fuels, are the major anthropogenic sources of carbon dioxide;

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

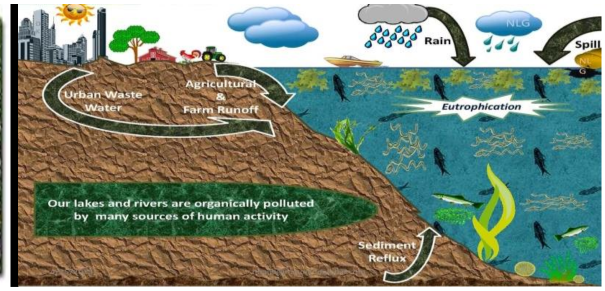
agriculture itself is the major contributor to increasing methane and nitrous oxide concentrations in earth's atmosphere.

2) Deforestation: Deforestation is clearing the Earth's forests on a large scale worldwide and resulting in many land damages. Deforestation causes the loss of habitat for millions of species, and a driver of climate change. Trees act as a carbon sink: that is, they absorb carbon dioxide, an unwanted greenhouse gas, out of the atmosphere. Removing trees releases carbon dioxide into the atmosphere and leaves behind fewer trees to absorb the increasing amount of carbon dioxide in the air. In this way, deforestation exacerbates climate change. When trees are removed from forests, the soils tend to dry out because there is no longer shade, and there are not enough trees to assist in the water cycle by returning water vapor back to the environment. With no trees, landscapes that were once forests can potentially become barren deserts. The removal of trees also causes extreme fluctuations in temperature. United Nations Food and Agriculture Organization (FAO) found that deforestation could result from "a combination of population pressure and stagnating economic, social and technological conditions".

3) Irrigation: Irrigation can lead to a number of problems among some of these problems is the depletion of underground aquifers through over-drafting of water. Soil can be over-irrigated because of poor distribution uniformity or management wastes water, chemicals, and may lead to water pollution. Over-irrigation can cause deep drainage from rising water tables that can lead to problems of irrigation salinity requiring water-table control by some form of subsurface land drainage. However, if the soil is under irrigated, it gives poor soil salinity control which leads to increased soil salinity with consequent buildup of toxic salts on soil surface in areas with high evaporation. This requires either leaching to remove these salts and a method of drainage to carry the salts away. Irrigation with saline or high-sodium water may damage soil structure owing to the formation of alkaline soil.

4) Pollutants: Synthetic pesticides such as 'Malathion', 'Rogor' and 'Kelthane' are the most widespread method of controlling pests in agriculture. Pesticides can leach through the soil and enter the groundwater, as well as in food products through food chain and result in death in humans and non-targeted wildlife. A wide range of agricultural chemicals are used and some become pollutants through use, misuse, or ignorance. The erosion of topsoil, which can contain chemicals such as herbicides and pesticides, carried away from farms to other places. Pesticides found in streams and groundwater. Atrazine is a herbicide used to control weeds that grow among crops. This herbicide can disrupt endocrine production, which can cause reproductive problems in mammals, amphibians, and fish that have been exposed. Pollutants from agriculture have a huge effect on water quality. Agricultural nonpoint source (NPS) solution impacts lakes, rivers, wetlands, estuaries, and groundwater. Agricultural NPS caused by poorly managed animal feeding operations, overgrazing, plowing, fertilizer, and improper, excessive, or badly timed use of Pesticides.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020



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a) Nitrate Pollution b) Eutrophication

Soil degradation is the decline in soil quality that can be a result of many factors, especially from agriculture. Soils hold the majority of the world's biodiversity, and healthy soils are essential for food production and adequate water supply. Common attributes of soil degradation can be salting, water logging, compaction, pesticide contamination and decline in soil structure quality, soil fertility loss, changes in soil acidity, alkalinity, salinity and erosion. Soil erosion is the removal of topsoil by water, wind, or farming activities. Topsoil is very fertile, which makes it valuable to farmers growing crops. Soil degradation also has a huge impact on biological degradation, which affects the microbial community of the soil and can alter nutrient cycling, pest and disease control, and chemical transformation properties of the soil.

c) Soil erosion

CONCLUSION: Rapid population growth as primary driving force connected with increasing food requirements generate great pressure on future land use, environment, natural resources, and ecosystem services. Intensive management practices increases land degradation, soil-water deterioration and adversely affect climate. The effects on the environment arise at site-specific level but can have impact at local to global levels. Land-cover changes cause the disappearance of traditional agricultural landscape and are responsible for vegetation modifications, which have an impact on regional climate, carbon sequestration, and biodiversity losses. Thus, the main role of future agriculture is its transformation into good productive but a sustainable system that can be effective for centuries without adverse effect on natural resources and environment on which agricultural productivity depends.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Emerging pests of peanut

Article id: 22937

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INTRODUCTION

The peanut or groundnut (*Arachis hypogaea*) is a species in the Family Fabaceae (commonly known as the bean, pea or legume family). Groundnut is an important oil seed crop out of the nine oilseeds crops grown in our country, Groundnut is the only crop cultivated in Goa during both the seasonsThe major area under this remunerative crop [1437 ha] however is during the Rabi season. Although this crop has limited acreage at present, there is good scope for bringing more area under this crop since the per unit productivity ranks third in the country [1.9 t/ha] as against the National average productivity of [1.0 t/ha] Groundnut crop is infested with sucking type of insects like aphids, leaf minor thrips leaf eating caterpillars, leaf webber in the initial and active growth stages. In the later stages, the crop may be attacked by Groundnut Earwig Or Pod Borer which punctures the developing pods causing heavy damage.

EMERGING PESTS

During the last decades, many new plant pests and diseases have emerged in different parts of the world, and this phenomenon seems to be accelerating . The introduction of pests into new areas can have serious economic and environmental impact.

1. White fringed beetles - *Naupactus leucoloma* , Curculionidae : Coleoptera
2. Southern corn rootworm - *Diabrotica undecimpunctata,* Chrysomelidae : Coleoptera
3. Lesser cornstalk borer - *Elasmopalpus lignosellus* , Pyralidae ; Lepidoptera
4. Wireworms -*Conoderus sp* , Elateridae ; Coleoptera

1.WHITE FRINGED BEETLES - *Naupactus leucoloma* :

A serious pest in some locations. If populations are high, they can make it impractical to grow susceptible crops on infested fields. More commonly, damage is patchy within the crop. Native to South America, whitefringed beetles were first reported in this country in 1936 as pests of tobacco in Florida. Whitefringed beetles infest at least 385 plant species. Some important host plants include tobacco, peanut, corn, Irish potato, soybean, velvet bean, strawberry, okra, cowpea.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

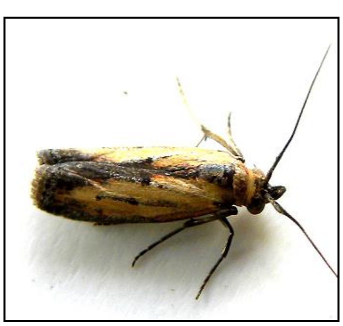
2.SOUTHERN CORN ROOTWORM - *Diabrotica undecimpunctata:*

The southern corn rootworm is widely distributed throughout most areas east of the Rocky Mountains, in southern Canada, and in Mexico. Southern corn rootworms have been found on more than 200 plants including common weeds, grasses, and cultivated crops. This insect is prevalent on corn and peanut, but it also attacks cucumber, squash, bean and other vegetables, melon, wheat, rice, millet, rye, oat, and alfalfa.

Damage to cucurbits is similar to that of the striped cucumber beetle. The adults feed on stems and cotyledons of seedlings and foliage, flowers, and fruit of older plants.They also spread bacterial wilt and squash mosaic virus. Larvae feed on the roots and weaken plants. Damage to com is caused mostly by the larvae. They bore into the stalk just above the roots and kill the growing point of young plants. They also feed on the roots, which can cause lodging and yield reduction.Damage is more likely in cool, wet springs, in low, wet areas and where corn has followed corn for several years. Adults are sometimes common enough to interfere with pollination by feeding on the silks.


3.LESSER CORNSTALK BORER: *Elasmopalpus lignosellus:*

Although the lesser cornstalk borer is found from Maine to southern California. It is also found in Mexico, Central America and South America. The lesser cornstalk borer prefers corn, but it also feeds on beans, cowpeas, crabgrass, Johnson grass, peas, peanuts, sorghum, soybeans, and wheat.The larva of this small moth has been sporadically injurious to the seedlings of many plant species, and seems to be on the increase in the South. Damaging stage : larvae feed just below soil surface. Larvae makes sand tubes on pods and stem High risk to peanut in hot dry years, sandy soil. Spreads southern stem rot between plants. Injury is caused when the larva bores into the stalk of the host plant, thereby disrupting the growing point. Damage can be slight, or it can kill the plant. Damage is most prevalent during drought conditions in crops grown on sandy soil

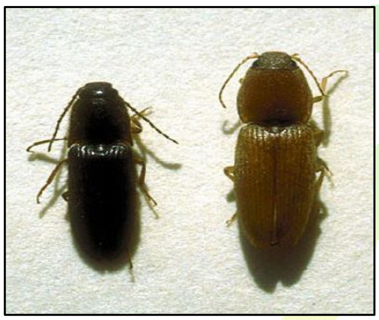



4.WIREWORMS - *Conoderus sp:*

Wireworms and False Wireworms occasionally cause damage to groundnut. Adult False wireworms (dusky brown beetles) occur on foliage and flowers. False wireworm larvae are white or cream, shiny, hard-bodied, and virtually indistinguishable, even to experts. Wireworms and false wireworms damage groundnut pods by boring through tile shell and eating tile seeds. In case of larva, they were also found to attack pods and devour the seeds inside.

Although tobacco wireworm larvae prefer tobacco, they also attack corn, cotton, potato, bean, peanut, and various truck crops. The adult beetles commonly feed on the weed mullein. *Conoderus lividus* larvae are most frequently found in bluegrass sod or in fields which were in sod the previous year. *C. lividus* beetles, on the other hand, are commonly found on trees and shrubs, especially walnut and hickory

Wireworm larvae damage peanuts by feeding in the seed, roots, underground stem and pods of the plant. Ragged holes are apparent in infested roots and stems. The above ground symptoms may include poor germination, chlorotic plants, and low productivity.



CONCLUSION

At the present time, there is no insecticide registered for control of white fringed beetles. Early planting and seeding rates near the maximum for the variety ensure a good stand. Trap crop - cucurbits, Some of the important natural enemies that attack cucumber beetles are Tachinid flies *Celatoria diabrotica* , Fungus *Beauveria*, and a Nematode *Howardula benigna*. These bio-pesticides and their soil-drenching formulations have shown some action against cucumber beetles larvae. Dimilin®2L is an insect growth regulator (IGR) that interferes with chitin deposition, resulting in production of a weak or malformed insect exoskeleton.

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Biocontrol potential of *Hirsutella rhossiliensis* against plant parasitic nematodes

Article id: 22938

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INTRODUCTION

Endoparasitic fungi are mostly obligate parasites. The entire vegetative stage has been spent inside the infected host. Endoparasitic fungi infect juveniles of plant parasitic nematodes using their spores (conidia or zoospores). The spores can either be ingested by the nematode), or adhere firmly on the nematode cuticle when the nematode passes the fungus. The spores are germinated in the intestines (mostly the esophagus or mastax) of the nematodes. Among the various endoparasitic fungi, in natural soil *Hirsutella rhossiliensis* is effectively parasitize over nematodes.

Hirsutella rhossiliensis

SYSTEMATIC POSITION

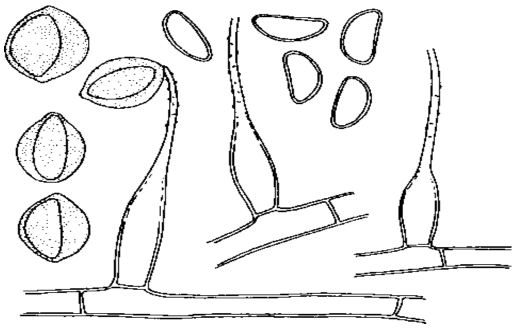
Kingdom	:	Fungi
Division	:	Ascomycota
Class	:	Sordariomycetes
Order	:	Hypocreales
Family	:	Ophiocordycipitaceae
Genus	:	*Hirsutella*
Species	:	*rhossiliensis*

H. rhossiliensis is first isolated from *Heterodera schachtii* by Minter and Brady, 1980. Later it is isolated from

1. *Criconemella xenoplax,* (Jaffee and Zehr, 1982)
2. *Heterodera schachtii ,* (Minter and Brady, 1980*)*
3. *Ditylenchus* (Cayrol and Frankowski, 1986),
4. *Xiphinema* (Ciancio *et al*., 1986),
5. *Meloidogyne* (Tedford *et al*., 1993),
6. *Globodera* (Velvis and Kamp, 1996)

MORPHOLOGY

Vermiform nematodes which are the juvenile stages of the nematode are parasitized by *H. rhossiliensis.* It is ubiquitous in nature. *H. rhossiliensis* produce simple erect bottle shaped phialides which are swollen at the base and taper towards the apex. At the tips of bottle-shaped phialides, non motile adhesive ellipsoid conidiospores are present.
(Picture source: Minter and Brady 1980, conidiophores and conidia of *Hirsutella rhossiliensis* drawn with and without slime layer)



***H. rhossiliensis* spores**

Spores which are attached on the phialides alone can able to adhere to nematodes. Once the spores are detached it will become ineffective. They may attach to the soil particles or they may germinate prematurely or they may not be positioned correctly for the adherence over the nematodes. *Hirsutella rhossiliensis* is a poor soil competitor because mixing of soil disrupts hyphae and detaches spores from phialides. Soil cultivation is likely to reduce the innoculum potential of *Hirsutella rhossiliensis* in the field due to the detachment of spores.

MODE OF ACTION

Spores of *Hirsutella rhossiliensis* adhere to cuticle of nematode juveniles.the body content of the nematodes assimilated by the spores which penetrates into nematode cuticle. After penetration, it emerges and sporulates.

FORMULATIONS AND ITS BIOCONTROL POTENTIAL

- Eventhough the fungus is highly pathogenic, slow growth characteristics and weak competitiveness in the soil ecosystem has limited its biocontrol potential.
- These limitations might be overcome by the use of an efficient delivery method designed to protect *H. rhossiliensis* against unfavorable soil conditions, and to support its growth after application by providing a selective food source.
- Formulations based on alginate granules were shown to increase control efficacy of *H. rhossiliensis* under greenhouse conditions, but efficacy under field conditions was limited. Some alginates were also too costly for large-scale application.
- An alternative formulation could be based on microcapsules produced on raw materials such as cellulose where the fungus is completely protected by a semi permeable membrane.
- Encapsulation within a matrix has the advantage to protect the sensitive biomass from biotic and abiotic stress factors such as soil antagonists, temperature and dryness, UV light and mechanical stress by providing a beneficial microenvironment.
- *H. rhossiliensis* which obtained through the isolation from the soil is maintained in potato dextrose broth. From the broth hyphal mat is collected and macerated with 1% alginate and pellatized with $Cacl_2$. In laboratory condition, the alginate pellets of *H. rhossiliensis* cause 55% suppression of *M. javanica.* When it is applied in the microplots, it cause about 30% suppression of *M. javanica.* Pelletized *H. rhossiliensis* worked well in the laboratory but poorly in microplots. Invasion of tomato seedlings by *M. javanica* J2 was reduced by 50% when 50

pellets of *H. rhossiliensis* were added to 100 cm3 of loamy sand infested with egg masses of the nematode. Both dry and moist pellets are used to control the nematodes.

- Capsules containing 1% finely dispersed fungal mycelium increased control efficacy of *H. rhossiliensis* compared with finely dispersed mycelium applied directly to the soil.
- Finely dispersed mycelium may contain more viable cells than mycelium grown in pellets. Improved viability of the fungus should lead to higher levels of control efficacy. The positive effect of fungal protection by microencapsulation is probably equivalent to the effect of better dispersal following direct application. Invasion *H. schachtii* was 29% lower compared with control plants.
- Nematode invasion was reduced by the addition of autoclaved baker's yeast. As the baker's yeast is the nutrient source for the growth of the mycelium which bears conidiospores
- Treatment with fungal capsules containing 1% and 3% baker's yeast caused a 51% and 83% reduction respectively.

This showed that the fungal capsules along with the additive baker's yeast alone suppress the population of *Heterodera schachtii* juveniles per cm root. The additive agent, baker's yeast provides food source for the growth of fungus so that it can be remained effective.

CONCLUSION

It is highly pathogenic to the nematodes. Microcapsules proved to be an effective delivery system for *H. rhossiliensis* and are considered to also have high potential for the formulation of other bio control organisms. Still there are many issues to be addressed to make *Hirsutella rhossiliensis* to be effective under field condition.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Guar gum and its use in food industry

Article id: 22939

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Guar gum is a novel agrochemical processed from endosperm of cluster bean. India is native of guar or cluster bean where it is used as a vegetable. Guar beans have a large endosperm which contains galactomannan gum which forms a gel in water, this is commonly known as guar gum. India accounts for 90 per cent of the world's guar produce, of which 72 per cent comes from Rajasthan. It is used in variety of foods as an additive because it changes the behavior of water present as a common component in various foods.

INTRODUCTION:

India is native of guar or cluster bean where it is used as a Vegetable. Guar gum is an extract of the guar bean, where it acts as a food and water store. Guar gum comes from the endosperm of the seed of the legume plant *Cyamopsis tetragonoloba*; an annual plant, grown in dry regions of India as a food crop for animals. The guar bean is principally grown in India and Pakistan, with smaller crops grown in the U.S., Australia, China, and Africa. The drought-resistant guar bean can be eaten as a green bean, fed to cattle, or used in green manure. For hundreds of years Guar has been used as vegetable in India. Guar is a rain-fed crop, sown in July-August and harvested in October-November. Being a leguminous crop, guar fixes nitrogen, making the soil fertile. The growing season of guar is 14 -16 weeks and requires reasonably warm weather and moderate flashing rainfall with plenty of sunshine. Too much rain can cause the plant to become more 'leafy' thereby reducing the number of pods or the number of

The guar seeds are dehusked, milled and screened to obtain the guar gum. It is typically produced as a pale, off-white colored, coarse to fine ground powder. Guar Gum (Galactomannan) is a high molecular weight carbohydrate polymer made up of a large number of mannose and galactose unit linked together. The crude Guar Gum is a greyish white powder, 90% of which dissolves in water. It is a non-ionic polysaccharide based on the milled endosperm of the guar bean (leguminous seed *cyamposis tetragonaloba*). The guar gum is produced from endosperm and consists mainly of gummy Polly groups of monogalactoses with small amount of fiber and minerals. Several methods have been used for the manufacture of different grades of guar gum but due to its complex nature, the thermo mechanical process is generally used for the manufacture of edible grade and industrial grade guar gum.

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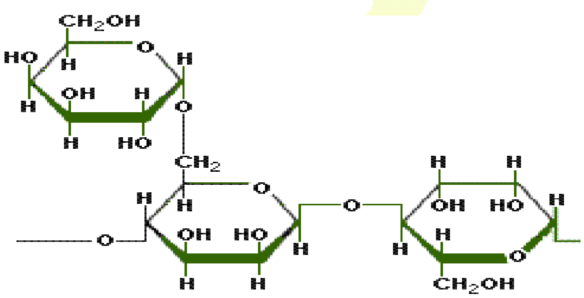
Guar meal is the by-product of Guar Gum, consisting of outer seed coat and germ material. After gum extraction, it is a potential source of protein and contains about 42% crude protein. The protein content in guar meal is well comparable with that of oil cakes. The consumption pattern of guar seeds is largely influenced by the demands from the petroleum industry.

Guar gum

Guar gum, a natural gum, is an edible thickening agent extracted from the guar bean. Guar beans have a large endosperm which contains galactomannan gum which forms a gel in water. This is commonly known as guar gum.

Components

Guar Gum mainly consists of hydrocolloidal polysaccharide with a high molecular weight, which consists of galactopyranose- and mannopyranose- units in glycoside linkage which can be chemically described as galactomannan.



Guar Gum Properties

- One advantageous property of guar gum is that it thickens without the application of heat.
- Easy solubility in cold and hot water.
- Film forming property.
- Resistance to oils, greases and solvents.
- Better thickening agent.
- Water binding capacity.
- High viscosity
- Functioning at low temperatures

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India accounts for 90 per cent of the world's guar produce, of which 72 per cent comes from Rajasthan.

Improved Varieties for Different Zone in Rajasthan

- Ageta Guara-111,
- Durgapur Safed
- GH-10,
- FS-277
- HFG-119
- **Jaipur Zone:** RGC-986, RGC-1O31, RGC-1038, RGC-1055 and RGC-1066.
- **Sikar Zone:** RGC-1002, RGC-1003, RGC-936, RGC-1066 and RGC-986.
- **Bikaner Zone:** RGC-1002, RGC-1003, RGC-1017
- **Jodhpur Zone:** RGC-1002, RGC-1003, RGC-1017 and RGC-936
- **Bharatpur Zone:** RGC-986, RGC-1O31, RGC-1038, RGC-1055 and RGC-1066.
- **Ganga Nagar Zone:** RGC-986 RGC-1O31, RGC-1038, RGC-1055 and RGC-10

Processing

1. Guar gum processing varies from plant to plant. The general outline of the manufacturing process of guar gum is shown in Fig. 1.
2. When guar seeds are removed from their pods these are spherical in shape, brownish in color, smaller than pea seeds in size.
3. The gum is commercially extracted from seeds essentially by a mechanical process of roasting, differential attrition, sieving and polishing.
4. The seeds are broken and the germ is separated from the endosperm. Two halves of the endosperm are obtained from each seed and are known as undehusked guar split.
5. When the fine layer of fibrous material, which forms the husk, is removed and separated from the endosperm halves by polishing, refined guar splits are obtained.
6. The hull (husk) and germ portion of guar seed are termed as guar meal which is a major byproduct of guar gum powder processing and is utilized as cattle feed.
7. The refined guar splits are then treated and finished into powders (known as guar gum) by a variety of routes and processing techniques depending upon the end product desired.

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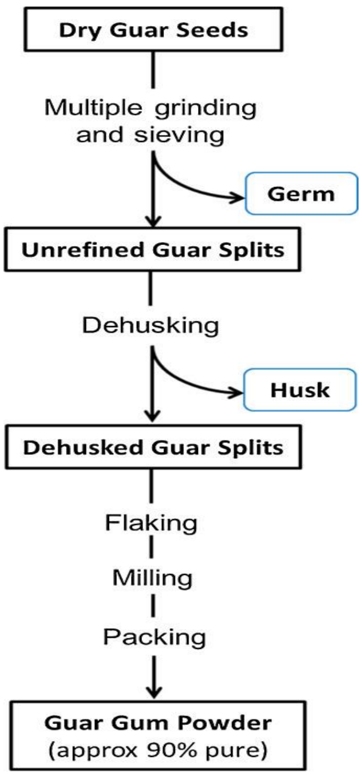

Fig.1 Flowchart for guar gum processing

Guar gum processing machine

8. The pre hydrated guar splits are crushed in flacker mill and then uniformly moved to ultra fine grinder, which grinds the splits without producing too much heat.
9. The grinded material is dried and passed through screens for grading of the material according to the particle size.
10. Various grades are available depending upon color, mesh size, viscosity potential and rate of hydration. In industrial processing of guar gum extrusion is also included before hydration and flaking.
11. After these steps grinding and drying are done. Inclusion of extrusion gives guar gum powder with improved hydration rate

Use of guar gum in food industries:

In Food Industry Guar gum is used as gelling, viscosifying, thickening, clouding, and binding agent as well as used for stabilization, emulsification, preservation, water retention, enhancement of water soluble fiber content etc.

- Guar gum can only be used for its beneficial effects at lower concentration of about 0.5–1.0%.

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Beverages

Guar gum is used in beverages for thickening and viscosity control because of its several inherent properties. The important property of guar gum is its resistance to breakdown under low pH conditions present in beverages. Guar gum is soluble in cold water which makes it easy to use in beverage processing plants. It improves the shelf life of beverages.

Processed cheese

In cheese product, syneresis or weeping is a problem of serious concern. Guar gum prevents syneresis or weeping by water phase management and thus also improves the texture and body of the product. In cheese products it is allowed upto 3% of the total weight. Guar gum in the soft cheeses enhances the yield of curd solids and gives a softer curve with separated whey. Low-fat cheese can be produced with addition of guar gum (at concentration 0.0025–0.01% w/v) without changing the rheology and texture compared with full fat cheese.

Dairy products

Main purpose of using guar gum in frozen products is stabilization. Guar gum has important role in ice cream stabilization because of its water binding properties. Its use in high temperature short time (HTST) processes is very favorable because such processes require hydrocolloids that can fully hydrate in a short processing time.

Guar gum should be used in ice cream mix at a concentration level of 0.3%

Processed meat products

Guar gum has strong water holding capacity in both hot and cold water. Hence, it is very effectively used as a binder and lubricant in the manufacturing of sausage products and stuffed meat products. It performs specific functions in processed meat products like syneresis control, prevention of fat migration during storage, viscosity control of liquid phase during processing and cooling and control of accumulation of the water in the can during storage. Guar gum also enhances the creaming stability and control rheology of emulsion prepared by egg yolk.

Bakery products

In wheat bread dough, addition of guar gum results in significant increase in loaf volume on volume on baking. Guar gum along with xanthan gum retard staling in gluten-free rice cakes by decreasing the weight loss and retro gradation enthalpy. Similarly, guar gum also retards staling in chapatti at room temperature as well as refrigerated temperature by controlling retro gradation of starch.

Salad dressings and sauces

Its cold water dispersibility and compatibility with high acidic emulsions enable it to use as thickener in salad dressing at about 0.2–0.8% of total weight. In salad dressings, it acts as an emulsion stabilizer by enhancing the viscosity of water phase and hence decreasing the separation rate of the water and oil phase.

Guar gum enhances the consistency of tomato ketchup more prominently than other hydrocolloids like carboxy methyl cellulose, Sodium alginate, gum acacia and pectin. On addition of guar gum serum loss and flow values of tomato ketchup decreases which makes it a novel thickener for tomato ketchup.

CONCLUSION

Guar gum is an important agrochemical derived from the seed endosperm of guar plant i.e. *Cymopsis tetragonoloba* which is cultivated in India and Pakistan from ancient times. Guar gum is a useful material to investigate. It has a strong hydrogen bond forming tendency in water which makes it a novel thickener and stabilizer. Aqueous solutions of guar gum are very viscous in nature. Because of these properties it has wide applications in the industries like food, pharmaceutical, textile, oil, paint, paper, explosive and cosmetics. Another reason for its popularity in the industry is its low cost. Its economical nature makes it popular in gums and stabilizers industry. In food industry, it has wide applications in ice cream, sauce, beverages, bakery and meat industry. It is also used in food products for supplementation as dietary fiber. Its consumption reduces the risk of heart diseases by reducing the cholesterol level in body, control diabetes and maintains the bowel movement in human beings.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

HATCHERY MANAGEMENT - SANITATION AND FUMIGATION

Article id: 22940
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INTRODUCTION

The poultry in the country is 851.81 million in 2019, registered an increase of 16.8% in the total poultry. The total birds in the backyard poultry in the country is 317.07 million. The backyard poultry has increased by around 46% and the total commercial poultry in the country is 534.74 million in 2019, increased by 4.5% over previous census GOI, DAHD 2019. Poultry farming become one of the fastest growing segments in agriculture sector. Increase in meat and egg consuming population is one of the main reasons behind it. The Indian poultry industry has undergone a paradigm shift in structure and operation it has transformed from backyard poultry farming to commercial poultry rearing just about few decades. The main reason behind it is investment in various sectors of poultry farming like breeding, hatching, rearing, processing etc. In recent years many changes have taken place in hatcheries, such as the introduction of computer monitoring and control of the machines, and automation of many day-to-day hatchery operations. The main factor is increasing awareness of the role of the hatchery in disease control for that proper management of hatchery and sanitation, fumigation of hatchery is required. The measure of success of any hatchery is the number of first-quality chicks produced. This number expressed as a percentage of all eggs set for incubation is normally termed hatchability. Hatchability is influenced by many factors. Some of these are the responsibility of the hatchery management like sanitation, fumigation, egg storage, egg damage, incubation-management of setters and hatchers, chick handling etc.

Hatching Egg Management

- Optimum hatchability and chick quality can only be achieved when the egg is held under optimum conditions between laying and setting in the incubator.
- Fertile egg contains many living cells.
- Remove dirty, cracked, small, very large or double yolk, poor shells but any shell color should be acceptable for hatching and grossly miss shaped eggs.
- Egg weight should be 50-55 g.
- Use fertile eggs collected and packed separately from nest eggs, and clearly identified.
- Place hatching eggs into the setter tray or transport tray, small (pointed) end downward.
- Store the eggs in a separate room in which the temperature and humidity are controlled.

Egg Storage

- There are three storage areas: farm egg room, transport, and hatchery egg room.

- Eggs should be collected from the farms and transported to the hatchery at least twice a week.
- Avoid changes in temperature and humidity, which can lead to sweating on eggs or eggs being chilled or overheated.
- On farm egg room temperature should be 70-77º f (21-25º c) and hatchery egg room temperature should be 66-70º f (19-21º c).
- Storage prolongs incubation time. On an average, one day's storage adds one hour to incubation time.
- Minimum storage period is six days.
- Hatchability and chick quality will be affected by prolonged storage.
- Storage conditions must therefore be designed to minimize these losses.

Incubator (Setter) Operation

To avoid temperature shock to the embryo and consequent condensation on the shell, eggs should be removed from the egg room and pre-warmed before setting. Ideally, eggs should be pre-warmed at around 75-80 °F (24-27 °C) for 6 to 12 hours so that all can achieve the desired temperature. Provide good air circulation around the eggs. In the incubator (setter) most of the embryo development will occur in 18 days.

The Optimum Physical Conditions in Setter for Embryo to Grow Successfully

- Temperature: 99.5 ^{o}F-100.4 ^{o}F (Sometimes hatchery dependent)
- Relative humidity: 50-60% for best hatchability, an egg must lose 12% of its weight by 18 days of incubation.
- Turning: Eggs must be turned during incubation. This prevents the embryo from sticking to shell membranes, particularly during the first week of incubation, and aids development of the embryonic membranes.24 times/day turning is required.
- Air quality is another factor in hatchery management that must be controlled. 1% drop in O_2 in hatchery will drop 5% hatchability.

Egg Transfer

Eggs are removed from the setter after 18 or 19 days and transferred to the hatcher trays. This is done to allow free movement of the chick out of the shell at hatching. Position of egg in hatcher tray will be horizontal. At transfer, eggs may be candled to enable clears (infertile and early dead germs together with rots) to be removed and counted.

Operation of Hatchers

The hatcher will be washed and disinfected between hatches, which means durability of construction and ease of cleaning are vital factors. Moisture is important during the hatching process to ensure the shell membranes remain soft and pliable so that the chick can escape unhindered. From point of transfer to piping, airflow in the hatcher should be maintained the same as in the setter. Hatcher temperatures are usually slightly lower than those of the setter to reduce the risk of overheating and humidity should increase in hatcher. The optimum physical conditions in hatcher are: Temperature: 98.5^{o}F and Relative humidity: 75%.

Chick Pull and Processing

Chicks are ready to be taken off when most of them are dry and fluffed up. Upon pulling chicks, they have to be separated from their debris, graded into first quality and culls, and counted into boxes. During processing, chicks must be held in a controlled environment that prevents overheating or overcooling. They must not be overcrowded in the boxes or while on conveyers. To reduce weight loss from the chicks, maintain the correct humidity in the chick holding areas. Aim for 23 °C (73 °F) with a relative humidity of 65-70%. Clean all equipment thoroughly after each hatch.

Sanitation and Disinfection in hatchery:

- Hatchery hygiene was evaluated in two commercial broiler hatcheries using open plate method, surface swabbing and microbiological examination of hatchery fluff.
- A sanitation program should be devised to control contamination, and the results of the program.
- Sources of contamination other than infected eggs and chick fluff are air, people (both workers and visitors), animals such as rats and mice, wild birds and insects, and equipment such as boxes, trays and buggies.
- Ensure all workers and visitors wear suitable protective clothing.
- Before using any disinfectant, it is important to remove all organic matter. All debris must be removed by sweeping, vacuuming or by spraying water. Hatchers should be washed out thoroughly with water and detergent before disinfection.
- Disinfectants must be used strictly in accordance with the manufacturer’s instructions.
- Disinfectants used must comply with government regulations.
- Dirty water lines may help to transmit disease agents therefore water line sanitation is important. Chlorine is effective as a sanitizer at 3-10 ppm and iodophors at 12.5-25 ppm.

Table.1 Fumigation Levels Under Different Conditions of Usage

Conditions for use	Formaldehyde strength	Quantities needed to produces the formaldehyde gas		Fumigation time (min)
		Formalin (ml)	$KMnO_4$ (g)	
Hatching eggs immediately after they are laid	3X	120	60	20
Eggs in incubators (1st day only)	2X	80	40	20
Incubator room	1X	40	20	30
Hatcher	3X	120	60	30
Chick room	3X	120	60	30
Chick boxes, pads	3X	120	60	30

CONCLUSION

Disinfecting substance generally has biocidal effects on various microorganisms like bacteria, fungi and viruses which are the source of causing the diseases in birds. Those disinfectants whose biocidal effects are swifter and longer and which are more ecological, less odorless, easier to use, non corrosive, economic and do not harmful effect on humans and animal health. In other hand these sanitizers and disinfectants will protect from harmful disease causing organism and it will reduces the mortality rate and helps in increasing the net income of the hatchery.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 **Volume 2 – Issue 2 – February 2020**

Control measures of extreme hydrological events: Flood & drought

Article id: 22941

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Flood and Drought are two extreme hydrological events. These cause severe damages in life and property. So adoption of control measures is very essential to reduce the effect of flood and drought. Flood is basically defined as the high stage in river and water course. The damages caused by flood in terms of loss of life, property and economic losses. The flood peak is required for the designing of hydraulic structure, bridge, culverts waterways and spillway of dam.

The flood control measures that are in use can be classified as –

1. **Structure measures –**
   - **Storage and detention reservoir –** flood storage structures are most reliable and effective methods for controlling the chance of flood. In this, reservoir is to be used to store the excessive water and further excessive water is released in control way over a long period of time. So the downstream side is not affected by the flood. Detention reservoir, construct the obstruction in the river with uncontrolled outlet. These types of structures are not common in India.
   - **Levees –** It is common and oldest measure used to control the flood. These type of control measures basically constructed parallel to the side of with river course with sufficient height and with freeboard to reduce the damage caused by flood.
   - **Flood ways –** Flood ways are manmade and natural channel from which a part of flood will be diverting during high discharge.
   - **Channel improvement –** To reduce the damage caused by flood, channel must be made by considering following conditions –
     I. Channel must be sufficient wide and deep enough, which increased the cross section area of channel, so more water is to be stored in channel and reduce the chances of flood.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

II. Reduce the roughness of channel by cleaning the vegetation from the channel perimeter.

- **Watershed measurement** – watershed management

2. **Nonstructural measures –**
   - **Flood plain zoning** – Flood plain management identifies the flood prone areas of a river & regulates the land use to restrict the damage due to flood. The location & extent of areas likely to be affected by flood of different return periods are identify & development plans of these areas are prepared in such a manner that the resulting damage due to flood are within acceptance limits of risk.

Zone	Flood return period	Area used
1	100	Residual house, factories
2	25	Parks
3	frequent	No construction

   - **Flood forecasting and warning** – Forecasting is a warning system which is provided to the people at appropriate time and provided appropriate precautions measures. Requirement of reliability and advance notice are the essential ingredients of a flood forecasting system.
   - **Evacuation and relocation** – Evacuation of communities along with their live stocks and other valuables in thee chronic flooded affected area and relocation of them in nearby safer locations is an area specific measure of flood management.
   - **Flood insurance** – Flood insurance provides a mechanism for spreading the loss over large numbers of individual and thus modifies the impact of loss burden.

Drought is a climatic phenomenon characteristic by deficit supply of moisture. This may result from subnormal rainfall over large region causing below normal natural availability of water over long period of time.

Drought Management – The cause of drought are especially due to temporal and spatial changes due to rainfall, improper management of available water and lack of soil and water conservation.

Drought management involve-

1. **Short term strategies –** It is involve early warning, monitoring and assessment of drought.
2. **Long term strategies –** It is involving aim at proving drought mitigation measure through proper soil and water conservation, irrigation scheduling and cropping pattern.

List of possible modification of various drought components-

- Creation of water storage through appropriate water resources development
- Inter basin transfer of surface water from surplus water area to drought prone areas
- Development & management of ground water potential
- Soil moisture conservation measure
- Economic use of water in irrigation such as drip irrigation & sprinkler
- Reduction of evaporation from soil and water surfaces.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Use of Metabolomics Assisted Breeding in Crop Improvement

Article id: 22942

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INTRODUCTION

The genome-sequencing projects have resulted in generation of large amount of data on different aspects of plant species due to developments in various areas of genomics at a faster rate. The availability of complete genome sequences in many plant species has provided plant breeder an excellent understanding of the link between gene to protein. Still a vast gap exists between proteome and phenotype, which makes it's understanding cumbersome Metabolomics attempts to fill this gap.

What is metabolomics?

Metabolomics comprises all the metabolites representing the end products of cellular processes present in a cell, tissue, organ, or organism. The term metabolomics was defined for the first time by Oliver as the quantitative complement of all of the low molecular weight molecules present in cells in a particular physiological or developmental stage. Therefore, metabolomics is the systematic study of the characteristic small-molecule metabolite profiles generated by the various cellular metabolic processes. It is a complex field of analytical chemistry and bioinformatics in which advanced techniques are employed to determine the levels of a wide range of metabolites. The levels of metabolites can be regarded as the ultimate response of biological systems to genetic or environmental changes and these are indispensable component of plant metabolism which finally influence the plant biomass and architecture. Metabolomics has the ability to detect a vast array of metabolites from a single extract, thus allowing speedy and precise analysis of metabolites. In other words, metabolomics offers a comprehensive view of cellular metabolites like small organic compounds, which participate in different cellular events, thus representing the absolute physiological state of a cell.

Tools for metabolomic studies

Presently for metabolomic studies two approaches are used, namely mass spectrometry (MS) and nuclear magnetic resonance (NMR). The NMR based metabolite detection is based on utilization of magnetic properties of nuclei of atoms under magnetic field. The NMR is a non-destructive method extensively used to identify metabolites with smaller molecular weight (<50 kDa). The major limitation of NMR based approach is its poor sensitivity and large sample requirement. It is used mainly for identifying physical properties of ligands, binding sites on protein and uncovering structures of protein-ligand complexes etc. MS approach has allowed researchers to generate a wide range of metabolome data due to its higher sensitivity and resulted in identification of novel metabolic biomarker and molecules that can facilitate the better understanding of metabolic pathways and reconstruction of metabolic networks.

Application of metabolomics for crop improvement

Presently efforts in metabolomics have been mainly focused to improve the quality traits with a major focus on yield related traits. Metabolomics in integration with quantitative approaches, molecular plant breeding and different omics tools may provide immense benefits to a plant breeder for Crop improvement. An effective combination of these modern approaches guides researchers to pinpoint the functional gene(s) and the characterization of large number of metabolites, in order to search for the candidate genes and ultimately, to develop trait-specific markers to improve economically important traits. So, metabolomics can be used for crop improvement in various ways such as:

- ✓ **For gene identification:** Metabolomics study helps in identifying particular mQTL which corresponds to gene(s) related to that particular trait and thus it became easier to identify gene(s) responsible for that particular metabolite. The metabolite investigation of mutants and transgenic lines can help understanding the metabolic networks and to pinpoint the underlying candidate gene(s). Also, the metabolomics helps to resolve gene 's' function: how a particular gene impacts upon the metabolic pathway, and uncovers different layers of regulation and interception between linked, which otherwise is difficult to achieve by conventional assays like microarray.
- ✓ **To speed the breeding program:** Application of molecular tools such as enzyme-based markers, marker-assisted selection (MAS) has shortened the entire process of crop improvement from 10-12 years to 5-6 years. By using mQTL-based approaches, we may further reduce time up to 4 years.
- ✓ **To characterize GM crops:** Acerage under GM crops is increasing day by day. Metabolomics offers a great tool to characterize the biochemical status, including important nutritional and toxicological characteristics. The metabolite composition has close association with the plant phenotype. Also, a database of metabolites of both GM crops and traditional varieties can be generated with the application of metabolomic technology.
- ✓ **For improvement of quality traits in fruits:** Metabolomics studies have provided better understanding of fruit biology specially related to ripening and quality. Tomato is a rich source of carotenoids, antioxidants and flavonoids. By correlating fruit transcriptome with ripening events, diverse and differential biochemical pathways existing in the fruits of tomato has been searched. Apple contains beneficial nutrients including antioxidants that reduce the risk of asthma, cancer, cardiovascular disease, and diabetes. The metabolite contents of the apple fruits are used to differentiate commercially important cultivars. For example, the cultivar 'Golden Delicious' contains a high amount of myoinositol, sugars and succinic acid; whereas, the cultivars 'Granny Smith' contains high levels of unsaturated fatty acids (oleic and linoleic acid). So, with the help of metabolomics we can study the existing metabolites and as a result can improve the existing quality.
- ✓ **For improvement of cereal crops:** Cereals are the prime source of food worldwide. Cereals

have been widely studied in order to quantity variation in metabolites and their association with sequence variation. In rice, different research groups have harnessed the potential of metabolomics in order to explore the metabolites diversity between different varieties and natural variants. In maize, drought stress is reported to be regulated by amino acid metabolism. Photorespiration is tightly regulated under drought as the two amino acids involved in this pathway, glycine and serine are rendered up-regulated. Further, accumulation of glycine and myo-inositol was reported to relate with grain size of maize under drought, implicating these metabolites as potential markers for identifying drought tolerant maize. Similar work in rice demonstrated drastic induction of certain compounds in tolerant plants such as allantoin, galactaric acid, glucose, gluconic acid, glucopyranoside and salicylic acid, which could be considered as metabolite markers to address drought stress in rice

CONCLUSION

Metabolomics is key to understand the chemical footprints during different phases of growth and development of plants. To feed the ever-increasing population with limited resources and in a rapidly changing environment is the biggest challenges that the world faces today. To minimize this gap between production and demand new approaches are needed to discover and deploy agronomically important genes that can help crops to better withstand weather extremes and growing pest prevalence worldwide. To shift from single metabolite measurements to platforms that can provide information on hundreds of metabolites has led to the development of better models to describe the links both within metabolism itself and between metaboloism of a yield associated trait. In this context, metabolomics provides viable option, to deliver the future crops of immense potential. The ongoing efforts to elucidate the metabolic response to biotic and abiotic stresses indicate that Metabolomics assisted breeding might also be useful in the development of crops that are more resistant to these stresses. Thus, metabolomics-assisted breeding can be applied to for the improvement of traits related to biotic and abiotic stress and for quality improvement in cereals and fruits like other tools such as marker assisted selection for crop improvement.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 **Volume 2 – Issue 2 – February 2020**

MICRO-PLASTICS- "Minute particle with massive attention"

Article id: 22943

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In this modern era, human is capable of utilizing his brain to fight against all odds to live a hassle free life. Very little of the plastic we discard every day is recycled or incinerated in waste-to-energy facilities. Much of these end up in landfills, where it takes up to 1,000 years to decompose leading to leaching of potentially toxic substances into the soil and water bodies. The problem of plastic pollution has emerged in recent years and is being addressed in India across several states. The entry of micro-plastics in India has changed the status of plastic pollution crisis as they are nearly invisible to the naked human eye making it impossible for the regular consumers to identify and avoid. These plastic wastes, if not disposed in an eco-friendly manner, can have adverse environmental impacts.

INTRODUCTION:

Globally, plastic waste is categorised into four major classes based on size, i.e. macro-plastics (>25mm), meso-plastics (5-25 mm), micro-plastics (<5 mm) and nano-plastics (<100 nm) (Kim *et al.,* 2015; Koelmans *et al.,* 2015). Microplastics themselves are further divided into primary and secondary micro-plastics depending on their source (Li *et al.,* 2018; Pinon-Colin *et al.,* 2018). Primary micro-plastics are manufactured as microbeads, capsules, fibers or pellets. Examples include microbeads used in cosmetics and personal care products, industrial scrubbers used for abrasive blast cleaning and microfibers used in textiles. Primary microplastic can also come from the run-off/effluent of plastic product fabrication or manufacturing facilities. Secondary microplastics are the result of larger pieces of plastic breaking down into smaller pieces. This occurs when plastic debris is exposed to sunlight and the plastic begins to weather and fragment. It is generated by the fragmentation of larger plastic items by UV radiation, physical abrasion (waves, rocks), and microbial processes. Microplastics pollution is of increasing concerns, and has been listed as the second important scientific issue in the field of environment and ecology. The majority of plastic include polyethylene (PE), polypropylene (PP), polystyrene (PS), polyvinylchloride (PVC) and polyethylene terephthalate (PET) (Geyer *et al.*, 2017).

Microplastics are increasingly seen as an environmental problem of global proportions. While the attention on present day has been on microplastics in the ocean and their effects on marine ecosystem, microplastics in soils have largely been overlooked. Microplastics are considered as an emerging threat to terrestrial ecosystems, where soils may represent a larger reservoir for plastics than seas. Recently, scientists have found the fact that microplastics can actually affect agricultural growth and revealed that agricultural soil can contain more amount of microplastics in comparision to oceans. Terrestrial microplastic pollution is much higher than marine microplastic pollution – estimated at 4 to 23 times higher, depending on the environmental conditions. Inspite of the huge amount of microplastics present in soil, there is

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

no particular method for its quantification. In soil environments, main sources of microplastics include mulching film, sewage and sludge wastewater irrigation and atmospheric deposition.

1. Plastic mulch: Globally, plastic mulching has rapidly increased in the recent years, with an annual growing rate of about 5-10%. Large amounts of plastic films accumulate in the soil, and eventually break down into microplastics, and even nanoplastics. Plastic mulch films can risk microplastic contamination by fragmenting the larger foil pieces unintentionally left in the field. Thus, agriculture can be seen as victim of microplastic pollution on the one hand, but, may also play a role as polluter on the other. In a kilogram of soil, there can be over 40,000 micro-plastic particles. Most of these particles are fibers (up to 92%). The remainder (around 4%) are generally fragments.

2. Sewage and sludge: Sewage sludge is a principle waste. Fertilizer based on sludge contains valuable nutrients, but sustainable use requires that the levels of undesirable substances in the sludge is kept under control. Waste water treatment plants receive large amounts of microplastics emitted from households, industry and surface run-off in urban areas. Most of these microplastics accumulate in the sewage sludge. Today, sludge from municipal sewage treatment plants is applied to agricultural areas as a supplement to traditional fertilizers. These applications are generally well regulated as sludge might contain hazardous substances of different sorts. Microplastics are however not currently on the regulatory agenda for the use of sludge in agriculture which leads to potential risk of micro-plastic from sewage and sludge.

3. Atmospheric deposition: It is important to evaluate the amount of airborne microplastics in atmospheric deposition to estimate the total load of microplastics input into the environment. Microplastics transported in atmospheric deposition add to stormwater, which infiltrates the soil and runs into freshwater lakes and the oceans. Microplastics in the air are assumed to pose a health risk for humans. Small plastic particles and fibers could be breathed in and may settle in the lungs of adults and children. It has been found, that persistent organic pollutants and other harmful compounds accumulate on microplastics, such as trace metals and pathogens.

Estimation of micro-plastics in soil:

The process of microplastic analysis in soils is more or less similar with that in water column and sediments. Firstly, proper collection of soil samples is the most important step for microplastics analysis. Topsoil or deep soils within different layers are usually collected dependent on various types of soil utilization patterns. Sampling sites should be appropriately set in order to reflect the overall or average level of (micro-) plastic pollution in fields, so that subsequent analyses and quantification can accurately represent the status of soil microplastics. Secondly, soil samples should be dried, sieved, floated, filtered, and separated by density depending on the proportion of clay and organic matter content. Then, density extraction and digestion of organic matter are performed. Finally, the potential microplastics are visually identified under an optic microscope, followed by confirmation by micro-Fourier transformed infrared (m-FT-IR) and Raman spectroscopy. A few times of sieving and density separation appear to be the most appropriate protocols to deal with the soil, but still at present it needs various levels of standardization.

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Consequences of micro-plastics in terrestrial and marine ecosystem:

The fate of microplastics is closely related to soil physio-chemistry and biota. Microplastics can influence soil biota at different trophic levels, and even threaten human health through food chains. Additionally, microplastics can also act as a vector for the transfer of pollutants, either plastic additives or other toxicants absorbed from soil matrices, to soil biota and thus pose a hazard. Microplastics once entered into the soil will be stored, translocated, eroded, degraded and leached to groundwater, thus threatening organisms and further affecting human health. On the other hand, soil biota can influence the accumulation and fate of microplastics. Plastic particles have a very high content of carbon, and most of this carbon will be relatively inert, since the material does not readily decompose. Eventually this material will slowly be degraded, giving a very wide C : N ratio, which will lead to microbial immobilization. The addition of HDPE microplastics can interfere with the stability and formation of larger soil macro-aggregates through direct alterations within the binding mechanisms of the soil.

Micro-plastics are ingested by biota and get accumulated within organisms, resulting in physical harm, such as internal abrasions and blockages. Meanwhile, ingested micro-plastics release toxic contaminants such as monomers and plastic additives, which can lead to carcinogenesis and disrupt the endocrine system. Furthermore, micro-plastics can adsorb and concentrate hydrophobic organic contaminants such as polycyclic aromatic hydrocarbons, organochlorine pesticides, polychlorinated biphenyls, and heavy metals such as cadmium, zinc, nickel, and lead. After ingestion or inhalation of micro-plastics, the accumulated chemical contaminants may be released and leached into the gastrointestinal tract of aquatic organisms or the lungs of humans, adversely impacting human health and ecosystem. In addition, micro-plastics can increase the bioaccumulation of the released contaminants, leading to chronic toxicity.

Possible solution and removal technologies:

1. Drinking water treatment: Drinking water intended for human consumption goes through treatment processes that removes a wide range of impurities prior to distribution to customers. The extent of this treatment depends on the source of the water. Drinking water protection areas are established to protect groundwater from contaminants in the water catchment area. As microplastic particles are deposited on soils, they would be retained by the natural filtration capacity of the soil as for many other particles. Treatment processes for surface water have always been applied with the objective of removing living or inert particles in the same size range as microplastic particles by physical treatment steps such as sedimentation, coagulation – flocculation, flotation and filtration. So, the physical processes in place for treating surface water to remove small (e.g. *Cryptosporidium*, algae) and large particles would be effective for microplastics too. Also, turbidity measurements and other monitoring tools help to control the removal of all kind of particles in the micron range. As a result, with present practices, microplastics can be effectively prevented from entering the drinking water treatment works.

2. Waste water treatment: Microplastics (1–5,000µm), as compared to suspended solids in conventional Waste Water Treatment Plan's (50-500µm), are particles, which relies on settling and/or filtering technologies. To date, there is little systematic testing and practical experience as to how the removal of microplastics is affected by the operational performance and the conditions of current technologies.

3. Sludge treatment: The separation of primary and secondary sludge, where applicable, could be a preventing measure to limit the release of microplastics to soil. Technologies to separate all microplastics before they are captured in sludge are unrealistic today. However, screens, grit traps and fat skimming can probably remove a substantial share of the microplastics prior to their capture in sludge.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Farmer friend - *Trichoderma*

Article id: 22944

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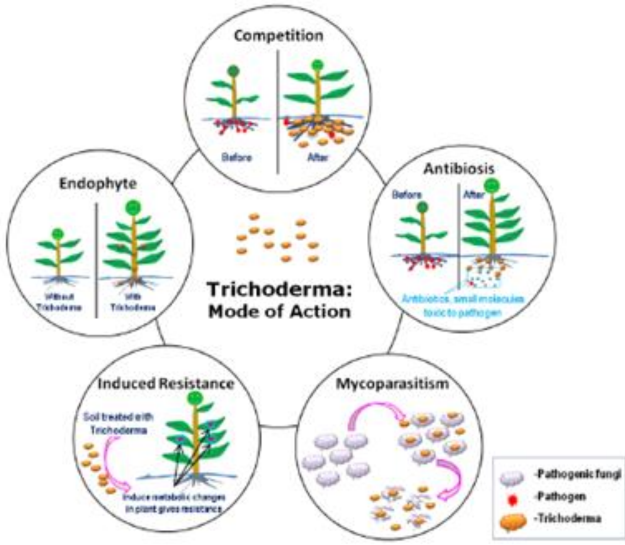
INTRODUCTION

Fungi in the genus *Trichoderma* have been known since at least the 1920s for their ability to act as biocontrol agents against plant pathogens. These fungi colonize the root epidermis and outer cortical layers and release bioactive molecules. *Trichoderma* produce a rich mixture of antifungal enzymes, including chitinases and β-1,3 glucanases. These principal mechanisms for control the pathogens and included mycoparasitism, antibiosis, and competition for resources and space.

Plant symbionts

Fungi in the genus *Trichoderma* and rhizobacteria in the genera *Pseudomonas*, *Bacillus, Streptomyces, Enterobacter*, and others have evolved multiple mechanisms that result in improvements in plant resistance to disease and plant growth and productivity. The action of *Trichoderma* spp. has recently been proposed.

- Inhibition of enzymes necessary for pathogens to penetrate plant surfaces
- Competition for nutrients including those necessary for pathogen propagules to germinate near planted seeds
- Control of root and foliar pathogens
- Induced resistance
- Biological control of diseases by direct attack of plant pathogenic fungi
- Changes in the microfloral composition on roots
- Enhanced nutrient uptake, including but not limited to nitrogen
- Enhanced solubilization of soil nutrients
- Enhanced root development
- Increased root hair formation
- Deeper rooting



Method of application:

- Seed treatment: Mix 6 - 10 g of *Trichoderma* powder per Kg of seed before sowing.
- Nursery treatment: Apply 10 - 25 g of *Trichoderma* powder per 100 m2 of nursery bed. Application of neem cake and FYM before treatment increases the efficacy.
- Cutting and seedling root dip: Mix 10g of *Trichoderma* powder along with 100g of well rotten FYM per liter of water and dip the cuttings and seedlings for 10 minutes before planting.
- Soil treatment: Apply 5 Kg of *Trichoderma* powder per hector after turning of sun hemp or dhainch into the soil for green manuring Or Mix 1kg of *Trichoderma* formulation in 100 kg of farmyard manure and cover it for 7 days with polythene. Sprinkle the heap with water intermittently. Turn the mixture in every 3-4 days interval and then broadcast in the field.
- Plant Treatment: Drench the soil near stem region with 10g *Trichoderma* powder mixed in a liter of water

Tricho-Compost

Tricho-compost is primarily used as a soil amendment. Like traditional compost, it improves soil structure, improves water holding capacity, can help regulate soil pH, and can assist with soil temperature maintenance. It should be applied at a rate of 2 to 2.5 tons/hectare to the crop field.

Benefits compared to traditional compost

Tricho-compost works as a natural antifungal agent against harmful fungi (*Pythium* sp, *Sclerotium* sp, *Phytophthora* sp, *Rhizoctonia* sp, *Fusarium* sp, *Botrytis* sp, *Sclerotoni a* sp), which are mostly responsible for soil born disease and fungal wilt.

Because of the inclusion of poultry refuse, Tricho-compost provides resistance against bacterial wilt and nematode infestation (Gapasin, 2007; Nahar *et. al*., 2012).

Recommended crops

Trichoderma is most useful for all types of Plants and Vegetables such as cauliflower, cotton, tobacco, soybean, sugarcane, sugarbeet, eggplant, red gram, Bengal gram, banana, tomato, chillies, potato, citrus, onion, groundnut, peas, sunflower, brinjal, coffee, tea, ginger, turmeric, pepper, betel vine, cardamom etc.

Uses of *Trichoderma* in pollution remediation

Trichoderma spp. probably have significant wide-scale uses in the remediation of pollutants in soils and waters. Shrub willow, *Salix eriocephala*, is an excellent candidate plant species for phytoremediation of cyanide- and ferrocyanide-contaminated soils and groundwater. *S. eriocephala* plants demonstrated the ability to take up and degrade ferrocyanide in hydroponic cultures with 15N-labeled cyanide or ferrocyanide, yet no cyanide remained in the aerial plant tissues. The combination of *Trichoderma* with shrub willows is expected to provide an effective method to degrade and remove cyanide and metallocyanides from a variety of polluted sites. These examples are a portion of the potential for use of *Trichoderma* spp. in remediation of polluted sites.

Precautions

- Don't use chemical fungicide after application of Trichoderma for 4-5 days.
- Don't use *trichoderma* in dry soil. Moisture is a essential factor for its growth and survivability.
- Don't put the treated seeds in direct sun rays.
- Don't keep the treated FYM for longer duration.

CONCLUSION

Trichoderma have long been recognized as biocontrol agents for the control of plant diseases and for their ability to enhance root growth and development, crop productivity, resistance to abiotic stresses, and uptake and use of nutrients. However, adoption rate of biopesticides is very slow, compared to synthetic chemicals. Among different biopesticides, *Trichoderma* is most important, having many success stories kumar *et*. *al*., (2017). A number of successful products based on different species of *Trichoderma* have been commercialized in India. *Trichoderma* isolates are formulated using different organic and inorganic bearers either through solid or liquid fermentation technologies.

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Understanding of nitrogen in agriculture

Article id: 22945

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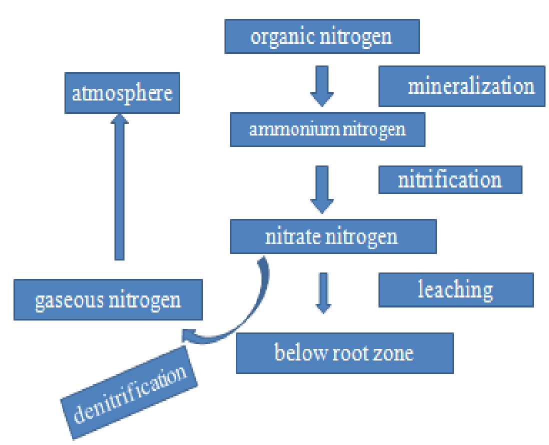
INTRODUCTION

Nitrogen (N) is the most imperative element for plant growth and development; it plays a vital role in morpho-physiological and biochemical function of the plant. Nitrogen (N) is the major constituent of nucleic acids, amino-acids, amides, proteins, nucleotides, coenzymes, hexoamines and occupies a conspicuous place in plant metabolism system. Inorganic forms of nitrogen are nitrates, nitrites and ammonia where as organic forms of nitrogen are amino acids, proteins, enzymes, nucleic acids, chlorophyll and vitamins. Nitrogen (N) is highly abundant in the atmosphere (about 78% by volume) and low concentration in sea water (0.00005 %), soil and crust rocks (0.002 %).

Nitric acid (HNO_3) or nitrate ion (NO_3-) is the most oxidized state of nitrogen. Nitrate ion is the common inorganic nitrogen in the soil and major important nutrient for higher plants. Nitric acid responsible almost exclusively for water pollution in groundwater, rivers, ponds and is responsible for acid rain. N_2O is known as "laughing gas" and global warming gas in addition to CO_2 and CH_4. Ammonia (NH3) or ammonium ion (NH4+) is the most reductive state of nitrogen.

'Nitrogen use efficiency (NUE)'' is predominantly used as an index in agronomy to describe crop response to applied N. The NUE can be defined as the maximum economic yield produced per unit of nutrient applied, absorbed or utilized by the plant to produce grain and straw. NUE is important characteristics for increasing the fertility rate, grain filling rate, total biomass production thus increase the crop yields. The management of the N nutrition is very difficult because lowland rice crop is conducive to N losses through ammonia volatilization, leaching, nitrification, de-nitrification and runoff, which decreases the availability of N. Nitrogen use efficiency can be improved by adopting fertilizer, soil, water, and crop management practices that will maximize crop N uptake, minimize N losses, and optimize indigenous soil N supply.

Nitrogen cycle :



Importance of nitrogen (N) in agriculture:

- N is a significant component and building blocks of amino acids, proteins, nucleic acids and other cellular organelles for all forms of life.
- Some Proteins are used for plant cell structure

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

and other proteins are responsible for synthesize enzymes to facilitate the biochemical reactions to sustain the life.

- N is an important component of nucleic acids such as DNA and RNA. There are four main nitrogenous bases found in DNA and RNA: cytosine (C), adenine (A), guanine (G), Uralic (U) and thymine (T).
- Vast amounts of N we found in the earth crust and in the atmosphere, nearly 78% of N are available in the air we are breathing.
- It is an important determinant for plant growth, development and crop yield.
- In the absence of N fertilization soil N will be depleted and small changes in total N in the soil can drastically reduced, and affect plant-available N supply.
- Applied N furnishes the requirement of plant N and soil N.
- N mineralization from soil organic matter and crop residues supplies inorganic N and nitrates to the soil.
- Plants and micro-organisms obtain available N from the surrounding soil and water. Animals get N from the food. A few other organisms get N directly from the pool of nitrogen gas (N2) in the atmosphere, by the expend of energy.

Nitrogen mineralizatioan

Organic forms of N such as amino acid, proteins are the unavailable forms of N to the plants. The inorganic forms of N (NH_4^+, NH_3, NO_3^- and NO_2^-) are the available forms of N to the plants and micro-organisms that can move in the soil by which water moves through it. N enters to the soil either by NO3- or NH_4^+ in rainfall (atmospheric deposition) or nitrogen fixing plants such as alfalfa etc. Humans also increase the N in soils by applying chemical or organic fertilizer. In the soil, the N transformation governs the processes of mineralization, immobilization, nitrification volatilization, denitrification, and plant uptake. Volatilization and denitrification—result in losses of N from the soil and N is also lost through leaching and runoff. In the N fixation plants and some micro-organisms converts air N_2 to organic N in the symbiotic relation with microbes. By decomposition, organic N transform to inorganic available form of N (NH_4) in the process of mineralization. Often during decomposition process soil micro-organism transform the inorganic N to organic N, temporarily locking up the N is called immobilization. When the C: N ratio greater than 30:1, then immobilization occurs, this is because micro-organism needs more N. When the C: N ratio is below 20:1, N mineralization is likely to occur. When the C: N ratio in between 20-30:1 both mineralization and immobilization may occur.

Transformation and chemical reactions in N-cycle

Transformation	Chemical reaction	Description
Nitrogen fixation	N_2+ 8H+ 8e^- + 16 ATP → 2NH_3+ H_2+ 16ADP+ 16PI	Biologically and non-biologically nitrogen is converted to ammonia.
Nitrification	NH3-N → NO2- N NO2- N → NO3- N	Oxidation of ammonia to nitrite and then to nitrate.
Mineralization	R-NH_2 → NH_4^+	Transformation of organic N to inorganic nitrogen.
Volatilization	NH_4^+ → NH_3 (aq) + H^+ NH_3 (aq) → NH_3 (g)	Loss of ammonia from soil to atmosphere.
Denitrification	2NO_3^- + 10e^- + 12 H^+ → N_2 + 6 H_2O	Microbial process nitrate is reduced and produces molecular nitrogen.

Source and sink relationship of N

High N produces high grain yield, because N application stimulates the growth of superficial roots and increases grain yield more efficiently by improving grain filling. Thus, N uptake is crucial in building up the internal N reservoir. The growth and activity of roots mutually correlated with shoots. A high photosynthetic rate of shoots secures high root activity by supplying a sufficient amount of photosynthates to the roots. Conversely, high root activity secures a high photosynthetic rate by supplying a sufficient amount of nutrients to shoots. In life cycle, management of N is divided into two main phases.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Nutrients and drug interaction

Article id: 22946
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INTRODUCTION

Although it is well known and identified that drug-drug interactions exist, the recognition of importance of food and drug interactions to practice has been growing much slower. On the other hand, drug-food/nutrient interactions continue to grow with the common use of medications. Beside the awareness of this type of interactions, food-drug interaction studies are critical to evaluate appropriate dosing, timing, and formulation of new drug candidates. Drug-food interactions take place mechanistically due to altered intestinal transport and metabolism, or systemic distribution, metabolism and excretion. In addition, some people have greater risk of food and drug interactions who have a poor diet, have serious health problems, childrens and pregnant women. In this article, basic information about importance, classifications, transporters and enzymes of drug and nutrient interaction are given and some specific examples of both drug and nutrients and influences on each other are included.

Definition of Terms

Drug-nutrient interaction: A drug/nutrient interaction occurs when a drug affects the use of a nutrient in the body. A drug-nutrient interaction is a reaction between a medicine and one or more nutrients. The result of the action between a drug and a nutrient that would not happen with the nutrient or the drug alone

Example -Foods high in vitamin K, such as spinach, broccoli, and kale. Eating foods high in vitamin K can keep warfarin (a blood thinner) from working properly. Foods high in tyramine, such as aged cheeses, can cause severe high blood pressure in people who take monoamine oxidase inhibitors (MAOIs).

There are too many potential drug-nutrient interactions (DNIs) due to the widespread use of patent medicines along with the broad variability in nutrition status, dietary habits, food composition, and dietary supplement use [Boullata and Hudson 2012]. Drug- -nutrient interaction is defi ned as an alteration of kinetics or dynamics of a drug or a nutritional element, or a compromise in nutritional status as a result of the addition of drug .

Another comprehensive definition of drug-nutrient interaction is that it is an interaction resulting from a physical, chemical, physiologic, or pathophysiologic relationship between a drug and a nutrient, multiple nutrients, food in general, or nutritional status.

DNIs can be mechanistically called in pharmaceutic, pharmacokinetic and pharmacodynamic terms. Pharmaceutical interactions involve physicochemical reactions that occur in a delivery device like enteral feeding tube or within the gastrointestinal lumen. These can affect the bioavailability of a drug or nutrient. Bioavailability is an important pharmacokinetic parameter which is correlated with the clinical effect of most drugs .For example, with the chelation in the presence of enteral nutrition formula, ciprofl oxacin bioavailability can be significantly reduced.

Drugs and nutrients can infl uence signal transduction pathways that ultimately impact drug-metabolizing enzymes and transporters through receptor-mediated gene expression. The more that is known about drugs serving as substrate, inducer, or inhibitor of various transporters and enzymes in various tissues, the closer that direct or indirect interaction with nutrients that infl uence these same proteins can be determined or predicted.

Pharmacokinetic interactions infl uence the disposition of a drug or nutrient in the body and involve effects on absorption, distribution, metabolism and excretion . Pharmacodynamic interactions involve the clinical effect of a drug or physiologic effect of a nutrient. Qualitative or quantitative measures of drug action or of nutritional status help to defi ne pharmacodynamic interactions.

CLASSIFICATIONS OF DRUG NUTRIENT INTRACTION

Drug-nutrient interactions could be classified into one of five broad categories (Table 1). The many typesnof drug-nutrient interactions could thus be categorized with each having an identifi ed precipitating factor.

Table 1. Classification of drug-nutrient interactions [Boullata, 2010]

Precipitating factor	Object of the interaction	Potential consequence
Nutritional status	Drug	Treatment failure Or drug toxicity
Food or food Component	Drug	Treatment failure or drug toxicity
Specific nutrient	Drug	Treatment failureor drug toxicity
Drug	Nutritional status	Altered nutritional status
Drug	Specific nutrient	Altered nutritional status

Food-drug interaction: A food/drug interaction occurs when a food, or one of its components, interferes with the way a drug is used in the body. It is a broad term that includes drug-nutrient interactions and the effect of a medication on nutritional status.

HOW DRUGS REACT IN THE BODY?

In order to understand food/drug and drug/nutrieninteractions, it is important to understand how drugs work in the body. There are four stages of drug action for medicines administered orally:

Stage 1: The drug dissolves into a useable form in the stomach.

Stage 2: The drug is absorbed into blood and is transported to its site of action.

Stage 3: The body responds to the drug and the drug performs its function.

Stage 4: The drug is excreted from the body either by the kidney, liver, or both.

Effects of Drugs on Food and Nutrition

- **Nutrient Absorption:** Certain drugs may increase, decrease, or prevent nutrient absorption in the gut.
- **Nutrient Breakdown:** Drugs may speed up the metabolism of certain nutrients, resulting in higher dietary requirements of that particular nutrient.
- **Nutrient Excretion:** Drugs can increase or decrease the urinary excretion of nutrients

Effects of drug/nutrient and food/drug interactions

- ✓ Type of medication
- ✓ Form of drug (pill, liquid, etc.)
- ✓ Dosage
- ✓ Site of absorption (mouth, stomach, intestine) • route of administration (oral, intravenous, etc.)

Risk Factors: Risk for food/drug and drug/nutrient interactions can be affected by many factors such as:

- ✓ Age
- ✓ Gender
- ✓ Medical history
- ✓ Body composition
- ✓ Nutritional status
- ✓ Number of medications used

Effects of nutritional status on drugs

The presence of nutritional abnormalities might have an effect on drugs. Drug dosages may need adjustment based on actual body weight for some drugs. Based on actual, ideal, or an adjusted body weight corrected for lean body mass, other drugs can need to be dosed differently in obese, normal, and underweight patients. Somatic protein status may affect the dosing of medications that bind to somatic protein. Although the influence on drug metabolism has been recognized, drug disposition is much less frequently assessed based on nutritional status (e.g., protein-calorie malnutrition, obesity, micronutrient deficits). The nutritional status of subjects in clinical drug trials has not always been well described. The influence that nutrition status might have on drug disposition and effect is included as one of the five broad categories in the classify- cation of drug- nutrient interactions. In the way that a precipitating factor to the interaction, nutrition status might result in drug toxicity or drug treatment failure related to the malnutrition's degree. Related with other fi elds of drug-nutrient interactions, the data available to clinicians are limited for the influence of obesity on drug disposition and even less for PCM (protein-energy malnutrition).

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Effects of drugs on nutrition status

Some drugs can have an effect on a patient's nutritional status. The mechanisms for these effects are varied and are usually due to drug side effects. Drug can enhance or inhibit nutrient bioavailability. Thus, it affects the nutritional status of individuals. For instance, elderly people, who are taking multiple medications for a long period of time are often found to be deficient in one or more nutrients. Other age groups, such as young children and adolescents, are also particularly at risk. There is a potential problem with drug-nutrient interactions in adolescents because their nutrient needs are higher than those of adults. Pregnant women and infants are the other groups also at particular risk. The reason of these deficiencies is not only based on the chemical reactions between drugs and nutrients but also on the dose and duration of treatment exposure to the drug. Drugs can interfere with nutrient utilizations at several sites starting from the ingestion of the food to the final stage of excretion.

Drug interaction risk factors and importance in elderly

High-risk patients, such as the elderly patients taking three or more medications for chronic conditions, patients suffering from diabetes, hypertension, depression, high cholesterol or congestive heart failure should be especially monitored for such drug food interactions . Insuffi cient nutritional status can impair drug metabolism.

Some people at higher risk for drug-nutrient interactions. They are who have impaired hepatic, renal or gastro-intestinal function are nutritionally compromised due to chronic Disease have recent weight loss or dehydration are on multiple and prolonged drug therapy are at the extremes of age with changes in lean body mass, total body fluids and plasma protein concentration.

When the risk of interactions is mentioned, there is of teeny some doubt in people's mind about taking drugs on a full or empty stomach or using alcohol with drugs. These factors are described briefly below. In addition, grapefruit juice is an significant drink that has been subject of many scientificant studies related with the food and drug interactions. For this reason, it is useful to mention here, grapefruit juice in particular.

Taking drugs on a full or empty stomach: The effects of some medicines can change when using them on a full or empty stomach. In addition, some medicines will upset the stomach, and if there is food in the stomach, that can help reduce the upset. If medicine label has not got directions of use, the patients must ask their doctor or pharmacist if it is best to take medicines on an empty stomach, with food, or after a meal.

Taking drugs with alcohol: The alcohol can affect the work of medications in the basic conditions such as [FDA 2013]:

- ✓ Swallowing medicine with alcohol
- ✓ Drinking alcohol after medicine has been taken
- ✓ Taking medicine after alcohol.

Alcohol affects body processes and interacts with many drugs. It influences many types of medications especially antidepressants and other drugs that affect both brain and nervous system. For example, taking alcohol with metronidazole can cause flushing, headache, palpitations, nausea and vomiting. Patients should talk to their doctor about any alcohol that they use or plan to use.

Taking drugs with Grapefruit juice: Grapefruit juice and drug interactions are well known interactions as compared to other nutrients. However, its influence on all drugs is not known. This juice should not be taken with certain blood pressure-lowering drugs or cyclosporine for the prevention of organ transplant rejection. The reason is that grapefruit juice can cause higher levels of those medicines in the body, making side effects from the medicine more likely. The juice can also interact to cause higher blood levels of the anti-anxiety medicine Buspar (buspirone); the antimalarial drugs Quinerva or Quinite (quinine); and Halcion (triazolam), a medication used to treat insomnia Excessive ingestion of grapefruit juice increases the bioavailability of lovastatin, atorvastatin and simvastatin by 1400, 200 and 1500%, respectively. This may lead to drug accumulation and the possible development of adverse effects. The components which lead to all such negativite reactions in grapefruit juice are defi ned as naringin, naringenin, furanokumarin, bergapten (5-methoxypsoralen) and flavonoids.

CONCLUSION

Food and drugs, both are necessary for good health, but they sometimes also bring side effects and risks when used at same time. Thus, the interactions need to be well identified. Generally, the effect of food on drugs results in a reduction in the drug's bioavailability; however, food can also alter drug clearance. Drugs can influence food intake, digestion, absorption and excretions. Much more research is needed for identify cation of this kind of interactions and pharmacists should be aware of the necessity of monitoring for potential drug-food interactions and advising patients regarding foods or beverages to avoid when taking certain medications.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Off-season cultivation of vegetable

Article id: 22947

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Cultivation of fresh vegetables after or before their normal season is called as off season vegetable cultivation, which means cultivation of crop outside their regular cropping calendar i.e. when the supply is low and prices are high. The concept of off season vegetable cultivation is a bit new to the growers and they don't have complete knowledge regarding it. This is one of the modern practice which can give farmer higher profit and satisfy the requirement of consumers at anytime anywhere with more choices.

The main objective of off season vegetable cultivation is to produce and supply the vegetables to the market during their lean period.

Off season vegetable production can be obtained by different ways such as

- Availing and using different agro climatic conditions.
- Selection of improved varieties.
- Adjustment of planting time.
- Creating controlled environmental conditions by making plastic tunnels, polythene houses, permanent glass houses etc.

Off season vegetable planting have various advantages like:

- It helps in better/proper utilization of land and farm resource.
- The outcome obtained by the off season planting per unit is high.
- Now a days consumers prefer fresh vegetables even in the off season, this demand of consumer can be satisfied by off season vegetable production.
- Sometimes it is possible to export fresh vegetables and earn foreign exchange.
- It is a source of rich protective food and it adds to the nutritional security.
- It is suitable for seed production.

It also offers many benefits to the farmers like:

- This method of production is suitable to small and marginal farmers.
- This engages the farmer throughout the year which solves the problem of unemployment.
- Farmers can learn specific techniques of vegetable production, which enhances their knowledge and interest towards it.
- It develops confidence amongst farmers which make vegetable production as their main profession.

Due to off season vegetable production:

- Government is supporting this by introducing new policies.
- Co-operative marketing societies are also involving in this development process.
- The women are able to contribute equally in marketing activities.
- Farmers also started to establish linkage with the wholesalers and retailer in local market etc.

Apart from advantages there are some disadvantages of off season vegetable production like:

- The production cost of vegetables is higher.
- It requires more money to construct the plastic houses.
- It requires expensive seeds.
- It is possible on commercial scale, only in areas where marketing is not a problem.
- It requires regular supervision.
- It requires skilled knowledge than the normal season production.
- Sometimes it is also risk due to possibility of incidence of disease and pest.
- It can become a source of pollution.

Problems in off season vegetable cultivation

- Lack of continuous support of improved technologies.
- There is also unavailability of proper of proper packaging materials.
- There is no access of market information system.
- There is no crop insurance for this production.
- The production is affected by the government regulations.
- Unorganized market centers at the production area.
- There is also lack in marketing education and marketing extension system.

Opportunities in growing off season vegetables.

- It provides more open export markets to farmers and traders than the existing opportunities to traders at local regional and global level.
- It provides opportunities for exporters and various stakeholders.

Practical Tips for off season vegetable farming:

- Before planning to adopt this technique by and individual he/she should have some practical knowledge regarding it.
- Cultivation timing of vegetable has to be accurate.
- The market demand of the vegetable should be kept in mind and grown accordingly in order to obtain higher profit margin.
- Farmer should ensure that the plant they are growing must have self pollination ability under plastic sheet.
- Land which is being utilized for the purpose of off season vegetable farming should be tested which will help in determining the quality of land for agricultural purpose.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

An insight into Pesticide Compatibility

Article id: 22948

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In nature, insect pests and diseases occur simultaneously causing crop losses warning the farmers to take up effective control measures. As most of the pesticides are specifically toxic either to insect pests or pathogens, control of both with any single pesticide is not possible. Therefore, it is necessary to mix an insecticide with a fungicide/ bactericide and apply to a crop. By applying a mixture of two pesticides, the cost of control can be reduced provided if it does not cause an adverse effects on either the pesticides, crop growth or yield.

Generally, insecticides and fungicides are commonly applied at 5-7 days interval to manage insect pests and diseases. The judicious application of pesticides at the right time with recommended dosages makes them more effective. The end- users mostly ignore precautions and recommendations on the container label, which proves to be one of the main reasons for unsatisfactory performance of various fungicides, insecticides and herbicides. In economic point of view, the use of combinations of pesticides is a necessary practice especially in commercial agriculture and is widely followed by most of the professional fruit, flower and vegetable producers or growers in the country (Vidhyadhari, 2003).

The combination nor mixture of pesticides results in several problems. In such cases, the components of a pesticide mixture are said to be "compatible" or "incompatible". The ability of two or more components of a pesticide mixture to be used in combination without impairment of toxicity, physical properties or plant safety of either of the components is known as compatibility. However, incompatibility is a condition that may arise due to the use of a combination of two or more pesticides with resultant loss or impairment of effectiveness of either component, development of undesirable physical properties, reduction of toxicity or the initiation of plant injury response (phytotoxicity) (Sharvelle, 1961).

Incompatibility of pesticides may be of following types:

A. **Physical incompatibility**

   The physical form of the pesticide changes, and one of them becomes unstable or hazardous for application (agglomeration, phase separation, explosive reaction, etc.).

B. **Biological incompatibility (Phytotoxic incompatibility)**

   The mixed product exhibits phytotoxic action, which independently is not phytotoxic.

C. **Chemical incompatibility**

Chemical compounds in the two pesticides react with each other producing a different compound, reducing the pesticidal activity of the pesticides (Degradation of the active ingredient).

'Physical incompatibility' is when two or more pesticides are mixed and the result is an unstable mixture or a soapy flocculate. Usually, this may be visualized as layering or balling up or sediment formation affecting the efficacy of the pesticides. It can be caused by improper mixing, inadequate agitation or lack of stable emulsifiers in some emulsifiable concentrates. In most cases, solids settle out of the mixture or the mixture separates into layers after agitation. Sometimes, the mixture may curdle, gel or become sludge-like. Some poor mixtures develop when pesticides are mixed with hard water. A physically incompatible mixture may not be sprayable – and even if sprayed, the concentration will likely to vary during the application. Dikshitulu and Subbaratnam (1996) reported more sediment formation when permethrin was combined with carbendazim showing physical incompatibility. Manohar (2005) observed that endosulfan (EC) + hexaconazole, spinosad (SC) + hexaconazole and indoxacarb (SC) + hexaconazole were physically compatible.

In this test, initially take 500ml of standard hard water (0.304g calcium chloride and 0.139g of magnesium chloride hexahydrate in one liter of double distilled water) in a one litre jar to which add one insecticide and one fungicide/bactericide in the order:

1) Wettable powder (WP)
2) Dry flowables (DF)
3) Flowables (F)
4) Emulsifiable concentrates (EC)
5) Solubles designated as either solubles (S),
6) Soluble Liquids (SL), or soluble concentrates (SC).

The volume of insecticide and fungicide/ bactericide mixture is make up to one litre with hard water, agitate the mixture by shaking the jar and leave it undisturbed for 30 minutes. Record observations after 30 and 60 minutes with respect to foaming and sedimentation. Also, record the pH of insecticides, fungicides and bactericide alone and in combinations and categorise the mixtures in the scale given by Bickelhaupt (2012) as follows:

Scale	Category
< 4.5	Extremely acidic
4.5–5.0	Very strongly acidic
5.1–5.5	Strongly acidic
5.6–6.0	Moderately acidic
6.1–6.5	Slightly acidic
6.6–7.3	Neutral
7.4–7.8	Slightly alkaline
7.9–8.4	Moderately alkaline
8.5–9.0	Strongly alkaline
> 9.1	Very strongly alkaline

'Biological (Phytotoxic) incompatibility ' is when two or more pesticides used in combination result in injury to the host plants. Some pesticides are safe when used alone, but injurious in combination. The symptoms of phytotoxicity include chlorotic spots (Peshney, 1990) and foliage injury (Arthur, 1960), darkened shallow pits on fruits (Poe and Jones, 1972), scorching and bleaching of foliage and reduced growth.

Biological (Phytotoxic) incompatibility can be tested in the semi-field conditions viz. in glasshouse and screen house under controlled atmospheric conditions. Record the observations from second to tenth days after spraying for phytotoxic symptoms such as injury to the leaf tip, yellowing, wilting, necrosis, vein clearing, epinasty and hyponasty on the leaves. The extent of phytotoxicity can be recorded based on the scale prescribed by the Central Insecticide Board and Registration Committee (C.I.B and R.C).
The per cent injury was calculated by using the formula:

$$\text{Per cent injury} = \frac{\text{Total grade points}}{\text{Max.grade} * \text{No. of leaves observed}} * 100$$

Leaf injury was assessed by visual ratings in a 0-10 scale i.e.

Scale	Phytotoxic symptoms(%)
0	No phytotoxicity
1	1 to 10% phytotoxicity
2	11 to 20% phytotoxicity
3	21 to 30% phytotoxicity
4	31 to 40% phytotoxicity
5	41 to 50% phytotoxicity
6	51 to 60% phytotoxicity
7	61 to 70% phytotoxicity
8	71 to 80% phytotoxicity
9	81 to 90% phytotoxicity,
10	91 to 100% phytotoxicity

'Chemical incompatibility' is when two or more pesticides are mixed, there is a resultant loss or reduction of effectiveness of one or all components. For this reason, most of the organic pesticides should not be used in combination with alkaline compounds having pH > 7.0. Alkaline reactions usually reduce the fungitoxicity of carbamate fungicides. In chemical incompatibility, the activity of the mixture may be different than if the products were applied separately. The results can be either increased activity called synergism or decreased activity which is called antagonism. Rynaxypyr was found compatible with carbendazim plus mancozeb and can be safely used as a tank mixture for management of simultaneous infestation rice insect pests and diseases without any phytotoxic effect on rice (Seni *et al*., 2018).

Synergism is produced when the association of fungicides with insecticides leads to a joint action that is superior to the arithmetical sum of actions exercised by the single fungicide or insecticide. Ali and Singh (2003) showed synergism of mancozeb + endosulfan mixture which resulted in increased efficacy of fungicide against the C*ercospora* leaf spot of sesamum. Antagonism is the condition found when the efficacy of the association is below the arithmetical sum of actions expressed by the single fungicide or insecticide. The combination of monocrotophos with mancozeb showed decreased insecticidal activity against red cotton bug (Lakshminarayana and Subbaratnam, 2000). When the pesticide mixture yields neither increased nor decreased efficacy than the arithmetical sum of actions expressed by themselves when used alone, such condition is said to be showing independent effect upon mixing. Peshney (1990) reported no change in the activity of resultant pesticide mixture of carbendazim and carbaryl when used against *Myrothecium roridum* compared to their effects when used alone.

CONCLUSION

The multiple pest management can be achieved through the use of two or more pesticides, fungicides or even fertilizers and their application in the same operation in order to reduce the labour cost. The physical and chemical properties of the pesticides, fungicide, fertilizers should be well understood prior to their mixing. The incompatible pesticides should not be mixed and only the compatible pesticides can be mixed.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Biological control of post-harvest diseases of fruits

Article id: 22949

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INTRODUCTION:

Post-harvest diseases cause considerable losses to harvested fruits during transportation and storage. Synthetic fungicides are primarily used control postharvest decay loss. However, the recent trend is shifting toward safer and more eco-friendly alternatives for the control of post harvest decays. The various biological approaches, the use of antagonistic microorganism is becoming popular throughout the word. Several post harvest diseases can now be controlled by microbial antagonists. Although the mechanism by which microbial antagonists suppress the postharvest diseases is still unknown, competition for nutrient and space is most widely accepted mechanism of their action. In addition, production of antibiotics, direct parasitism and possibly induces resistant in the harvested commodity are other modes of their action by which they suppress the activity of postharvest pathogens in fruits. The international level different microbial antagonist like *Debaryomyces hansenii*, Cryptococcus *laurentii, Bacillus subtillis* and *Trichoderma harzianum* are being used.

A post harvest loss is any change in quality or quantity of a product after harvest that prevents or alters its intended use or decrease its value.

Biological control: The control of pathogen through employment of antagonist is popularly known as bio-control or Biological control.

Antagonist: The organism which suppresses the growth of another organism is known as antagonist.

Mode of action of antagonists:

Antagonism, in general operates in three ways *viz*.,

- **Antibiosis**: release of metabolites or chemicals by the antagonist which may suppress or kill the pathogen.
- **Competition:** where antagonist may deprive the pathogen of the food material and latter may starve.
- **Predation or Parasitism**: in which the antagonist may parasitize the pathogen and kill it.

Merits of Biocontrol agents:

- Biocontrol agents are harmless to human beings and animals.
- Cheaper than pesticides by 50% and Easy to deliver.
- Highly effective throughout the crop growth period with high rhizosphere competence.
- Broad spectrum activity, productivity and production.

- Improve plant growth and induce systemic resistance.
- High cost: benefits ratio and environmentally safe.
- There is no risk of resistance development in pathogen and residual effects in food and ground water.
- They are also compatible with bio-fertilizers.
- Amenability for mass production.

Table 1: Biological Control of Post Harvest Diseases of Important Fruit Crops:

Host	Diseases	Biological control	References
Mango	Stem end rot	*Bacillus licheniformis* (10^7-10^8 cfu/ml)	Korsten *et al.,* (2005)
	Anthracnose	*Bellary jail*	Nargund, M.K., Basavarajappa. (2006)
	Fruit rot	*Trichoderma* spp. ($5x10^5$ spores/ml)	Patil. (1992)
Grapes	Gray mould	*Debaryomyces hansenii*	Chalutz and Wilson. (1990)
Banana	Crown rot	*Bacillus subtilis* (10^7-10^8 cfu/ml)	Kulkarni, S. & Hedge, Y. R. (2006)
Citrus	Stem end rot	*Bacillus subtilis (10^7-10^8 cfu/ml)*	Pusey and Wilson (1988)
	Black rot	*Yeasts (10^6-10^7 cfu/ml)*	Chalutz and Wilson (1990)
	Penicillium rot	*Trichoderma viride ($5x10^5$ spores/ml)*	de Maltos (1983)
	Green mould	*Bacillus pumilus 1.6 x 10^{10-12} cfu/ml*	
Guava	Fruit rot / Canker	*Trichoderma spp. ($5x10^5$ spores/ml)*	Mujumdar *et al.,* (1995)
Jack fruit	Rot	*Trichoderma lignorum ($5x10^5$ spores/ml)*	Dutta (1983)
Coconut	Rot	*Aspergillus niger*	Dutta and Chatterjee (1998)
Strawberry	Rot	*Trichoderma spp. ($5x10^5$ spores/ml)*	Tronsmo and Dennis (1977)
Apple	Rot	*Antagonistic mixture*	Janisiewez (1997)
	Penicillium rot	*Candida spp.*	Mc Laughlin *et al* (1990)

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Table 2: Post-harvest losses due to diseases in Important Fruits

Sr. No.	Fruits	Losses (%)
1	Mango	40
2	Banana	20-80
3	Citrus	20-85
4	Grapes	27-30
5	Papaya	40-100

Source: Horticultural Marketing and Post-harvest Management, 2001

SYMPTOMATOLOGY

Mango: - 1) Stem end rot:

Causal organism: *Colletotrichum gloeosporioides*

Symptoms: Water soaked spots enlarge rapidly and the lesions extend to the pulp, at later stage the central portion turn dark brown with irregular light colored water soaked margin.

Mango Anthracnose:

Causal organism: *Colletotrichum acutatum.*

Symptoms: Circular, dark brown specks which enlarge and coalesce to form large spot and the lesions extend to the pulp; salmon or dark colored dot like acervuli appear at later stage.

Citrus:- 1) **Stem end rot :**

Causal organism: *Colletotrichum gloeosporioides.*

Symptoms: Water soaked spot appears near stem end of the fruits which turn tan to blackish brown. Infected fruits loose weight and remain undersized.

Citrus Black rot:

Causal organism: *Alternaria citri.*

Symptoms: Infected fruit produce blackish green mycelium on the surface. A fruit bears small black spots which may coalesce to cover the entire fruits.

Citrus Penicilium rot:

Organism: *Penicillium digitatum.*

Symptoms: An affected area gets covered with green or blue moldy growth and the fruit emits a foul smell.

Green mould of Citrus:

Causal organism: *Penicillium digitatum.*

Symptoms: Moulds cause watery rot during transit and storage in which the rind breaks easily on pressing. The affected area gets covered

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

with green or blue moldy growth and the fruit emits a foul smell.

Guava: 1) Fruit rot / Canker:
Causal organism: *Pestalotia psidii.*
Symptoms: Rust coloured necrotic spots which later increases and extends to the pulp. The centre of infection gets depressed.

Grapes: 1) Gray mould:
Causal organism: *Botrytis cinerea.*
Symptoms: Small, circular faint coloured spots. The affected areas turn slightly brown. The skin slips from the diseased spot; affected fruits shrivel and turn dark brown.

Banana: 1) Crown rot of banana
Causal organism: *Colletotrichum musae*.
Symptoms: Crown rot, light brown rot turns dark brown and extends to the fingers, fruit spot, fruit rot, circular light brown spots enlarge and coalesce to form larger dark brown spots. The lesions invade the pulp at later stage

Jackfruit: 1) Jackfruit rot:
Causal organism: *Rhizopus artocarpi.*
Symptoms: Premature fall of young fruits due to rotting and may result in heavy loss in yield under unusual humid conditions.

Coconut: 1) Coconut rot:
Causal organism: *Aspergillus tamarii.*
Symptoms: Lesions appears on the young fruits or buttons near the stalk, which later cause decay of the underlying tissues, shedding of female flowers (buttons) and immature nuts.

Table 3: Influence of Temperature and Relative Humidity (Storage) on Post-Harvest Diseases of Fruits

Sr. No.	Diseases	Host	Temperature (°C)		RH (%)
			Range	Optimum	
1	Stem end rot	Mango	15-35	25	100
2	Fruit rot	Guava	10-35	30	96
3	Black tip	Banana	7-31	25	97
4	Anthracnose	Banana	10-35	30	90-97
5	Anthracnose	Papaya	10-35	25	97

Source: Sharma and Mashkoor, (1998).

CONCLUSION:

- Post harvest diseases caused by biotic agents are posing serious threat causing accountable quantitative as well as qualitative losses in fruits and vegetables.
- The post harvest fungicidal treatment of horticultural produce though promising, but due to its residual effect and health hazards needs to be discouraged.
- To avoid / prevent the post harvest losses of the horticultural produce, treatment with antagonist (fungal and bacterial) is one of the most promising option, alone or in combination with fungicides
- Bacterial antagonist viz. *Bacillus subtilis*, *Bacillus. licheniformis*, *Bacillus. pumilus*; Fungal antagonist *viz.*, *Trichoderma viride*, *Trichoderma. lingorum*; *Aspergillus niger* and Yeasts (*Candida* spp.) were reported as effective biocontrol agents for the management of post harvest diseases of many fruit crops.
- Environmental condition (Temp. and R.H.) in storage and transit have also found to play important role in the development of post harvest diseases of the fruit crops; optimum temp. and relative humidity should maintained.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Potential of Agroforestry for Ecosystems Services

Article id: 22950

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INTRODUCTION

Agroforestry is a land use practice, which integrates trees with agricultural production systems enabling diversification for increased social, economic, and environmental benefits. Agroforestry is increasingly viewed as providing ecosystem services, environmental benefits, and economic commodities as part of multifunctional working landscapes. Agroforestry systems (AFS) render (1) provisioning of food, energy, and fodder; (2) regulatory services including microclimate modification, erosion control, mitigation of desertification, carbon sequestration, and pest control; and (3) supporting services, namely soil fertility improvement, biodiversity conservation, and pollination. Continued adoption of agroforestry systems in rainfed areas will enhance farm productivity and the livelihoods of small and marginal farmers substantially livelihoods through multiple products and services.

Agroforestry Practices in India

The agroforestry systems practiced in India include trees on farms, community forestry and a variety of local tree based practices. On the basis of nature of components, Dhyani *et al.* (2009) have reported the common twenty agroforestry systems being practiced in different agro ecological regions of India and these are:

Agroforestry systems	Agroforestry systems
Agri-silviculture (trees + crops)	Horti-olericulture (fruit trees + vegetables)
Boundary plantation (trees on boundary + crops)	Silvi-pasture (trees + pasture /animals)
Block plantation (block of trees + block of crops)	Forage forestry (forage trees + pasture)
Energy plantation (trees + crops during initial years)	Shelter-belts (trees + crops)
Alley cropping (hedges + crops)	Wind-breaks (trees + crops)
Agri-horticulture (fruit trees + crops)	Live fence (shrubs and under- trees on boundary)
Agri-silvi-horticulture (trees + fruit trees + crops)	Silvi or Horti-sericulture (trees or fruit trees + sericulture)
Agri-silvipasture (trees + crops + pasture or animals)	Horti-apiculture (fruit trees + honeybee)
Silvi-olericulture (trees + vegetables)	Aqua-forestry (trees + fishes)
Horti-pasture (fruit trees + pasture and animals)	Homestead (multiple combinations of trees, fruit trees, vegetable etc).

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Ecosystem Services from Agroforestry Systems

The integration of trees, agricultural crops, and/or animals into an agroforestry system has the potential to enhance soil fertility, reduce erosion, improve water quality, enhance biodiversity, increase aesthetics, and sequester carbon (Nair *et al.,* 2009). It has been well recognized that these services and benefits provided by agroforestry practices occur over a range of spatial and temporal scales (Table 1). Generally, ecosystem services are grouped into three categories (1) provisioning services (2) regulating services and (3) supporting services (Tallis and Kareiva, 2005).

Table 1. Spatial scales of various ecosystems services provided by agroforestry systems

Ecosystem Services	Spatial Scale		
	Farm / local	Landscape / regional	Global
Net primary production			
Pest control			
Pollination/seed dispersal			
Soil Enrichment			
Soil stabilization/erosion			
Control			
Clean water			
Flood mitigation			
Clean air			
Carbon sequestration			
Biodiversity			
Aesthetics/cultural			

Source: Izac (2003) and Kremen (2005)

Provisioning Services of Trees in Agroforestry Systems

Provisioning services are the products obtained from ecosystems, including genetic resources, food, energy, fibre and fresh water.

1. ***Tress as food, fuel and fodder source***

The small and marginal farmers in rainfed areas of India have long been practicing agroforestry – to meet their food, fodder and fuel requirements. Apart from ensuring food production, such systems also would enhance economic returns to the growers. Diversified production from agroforestry systems is a form of risk avoidance. The diverse products (fuelwood, fruits, vegetables, spices etc.), which are available year-round in systems not only contribute to food security during the "lean" seasons but also ensure food diversity (Kumar and Nair, 2004). They are also sources of mineral nutrients and vitamins for improving household nutritional security especially for 'at-risk populations' (*e.g.,* women and children) (Table 2).

Table 2. Nutritious agroforestry fruit trees for integration in farm lands

Common name	Botanical name	Source of nutrients
Cashew nut	*Annacardium occidentale*	Rich in protein and fibre
Ber	*Ziziphus mauritiana*	Rich in vitamin-C, Sodium and Potassium
Aonla	*Emblica officinalis*	Rich in vitamin-C, Sodium and Potassium
Jackfruit	*Artocarpus heterophylus*	Rich in vitamin-B, C and Potassium
Mango	*Mangifera indica*	Excellent source of vitamin-A and flavonoids
Pappaya	*Carica papaya*	Excellent source of vitamin- C and flavonoids
Sapota	*Acharas sapota*	Rich in dietary fibre
Bael	*Aegle marmelos*	Rich in vitamin- C, Potassium, Iron and flavonoids

Source: Behera and Pradhan (2014)

Regulation Services of Trees in Agroforestry Systems

1. ***Provide erosion control and soil conservation***

Agroforestry practices provide vegetative cover which reduces the impact of rain drop and provide protection to the soil, enhance soil productivity and contribute towards sustainable land management. Trees protect the soil surface *via.* two canopies: the litter layer and the leaf canopy, thereby decreasing runoff and erosion losses, dampening temperature and moisture fluctuations and in most cases, maintaining or improving soil physical properties. (Hulugalle and Ndi, 1993).

2. ***Pest and disease suppression in tree crop interface***

Pest suppression is a perennial challenge to farmers, and it is a very important ecosystem service. In the modern agriculture, reduction of agro-biodiversity and continuous monoculture of crops with minimal rotation has a tendency to deplete the soil and for crop pests to become endemic. Agroforestry increases plant diversity and structural complexity, with implications on pest population dynamics. There is growing evidence showing that some agroforestry practices can drastically reduce serious pests of maize such as termites (Sileshi *et al.,* 2005) and weeds (Sileshi *et al.,* 2006).

3. ***Trees for enhancing microclimate to offset climate variability***

Trees in agroforestry systems can modify microclimatic conditions by providing shade and windbreak. The trees bring about a whole complex of environmental changes, affecting not just available light but also air temperature, humidity, soil temperature, soil moisture content, wind movement, pest and disease complexes. These factors impact crops, and the effect can be beneficial to a wide array of crops (Sileshi *et al.,* 2007).

4. ***Trees augment carbon storage***

Carbon sequestration involves the removal and storage of carbon from the atmosphere in carbon sinks (such as oceans, vegetation, or soils) through physical or biological processes. The incorporation of trees or shrubs in agroforestry systems can increase the amount of carbon sequestered compared to a monoculture field of crop plants or pasture (Kirby and Potvin, 2007). Carbon sequestration potential of different agroforestry systems in different parts of India is given in Table 3.

Table 3: Total C storage under agroforestry systems in different regions of India

Region	Agroforestry system	Total C storage (t C/ha)
Semi-arid region	Silvi-pastoral system (age 5 years)	
	Acacia nilotica+ natural grass	9.5-17.0
	Dalbergia sissoo+ pasture	17.2
North western India	Silvopastoral system (age 6 years)	
	Acacia/Dalbergia/Prosopis+ Desmostacya	6.8-18.5
	Acacia/Delbergia/Prosopis+ Sporobolus	1.5-12.3
Central India	Agri-silviculture system (age 8 years)	
	Gmelina arborea	24.1-31.1
Arid region	Agri-silviculture system (age 8 years)	26.0
North-western Himalayas	Agri-horti-pastoral system	1.15

Source: Prajapat *et al*. (2014)

Supporting Services of Trees in Agroforestry Systems

Supporting ecosystem services are those that are necessary for the production of all other ecosystem services.

1. ***Biomass transfer***

The trees that can withstand pruning and having high rates of organic matter production can be combined in agroforestry systems with agricultural crops with added advantage of yielding products such as fruits, fiber, fodder, timber and fuelwood. Woody species grown in alleys/hedges/bunds outside the cultivated fields, therefore, may be able to transform less available inorganic forms of phosphorus into more available organic forms, as well as supply significant quantities of N and K, when their leaves are incorporated into the soil as biomass transfers (Sanchez *et al.,* 1997).

2. ***Trees as nutrient source***

Trees can provide nutrient inputs to crops in agroforestry systems by capturing nutrients from atmospheric deposition, biological nitrogen fixation (BNF), and from deep subsoil, and storing them in their biomass. Ecological interactions between trees and crops in agroforestry system are beneficial because: leguminous trees have a beneficial effect on soil fertility through nitrogen fixation, greater organic matter production, and recycling of nutrients, a combination of annual crops and trees increases biomass production because differences in rooting depth enable uptake of more water and nutrients (Young, 1986).

3. ***Stimulate nutrient recycling from the subsoil***

In annual cropping systems, nutrient recycling from the subsoil can be increased by the integration of deep-rooting trees. The uptake of nutrients by tree roots at depths where crop roots are not present can be considered an additional nutrient input in agroforestry systems. Such nutrients become an input upon being transferred to the topsoil *via.* tree litter decomposition.

4. Water quality regulation

Trees with deep rooting systems in agroforestry systems can also improve ground water quantity and quality by serving as a ‘‘safety net’’ whereby excess nutrients that have been leached below the rooting zone of agronomic crops are taken up by tree roots. These nutrients are then recycled back into the system through root turnover and litterfall, increasing the nutrient use efficiency of the system.

5. Trees enhance functional biodiversity

Agroforestry plays five major roles in conserving biodiversity: (1) agroforestry provides habitat for species that can tolerate a certain level of disturbance; (2) agroforestry helps preserve germplasm of sensitive species; (3) agroforestry helps reduce the rates of conversion of natural habitat by providing a more productive, sustainable alternative to traditional agricultural systems; (4) agroforestry provides connectivity by creating corridors between habitat remnants which may support the integrity of these remnants and the conservation of area-sensitive floral and faunal species; and (5) agroforestry helps conserve biological diversity by providing other ecosystem services such as erosion control and water recharge, thereby preventing the degradation and loss of surrounding habitat (Harvey *et al.,* 2007).

CONCLUSION

Awareness creation about tangible and intangible benefits and services from adopting agroforestry enterprise could go a long way toward sustaining the livelihood security in fragile rainfed ecosystem

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Significance of super absorbent polymers in conserving soil moisture for crop production

Article id: 22951

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INTRODUCTION

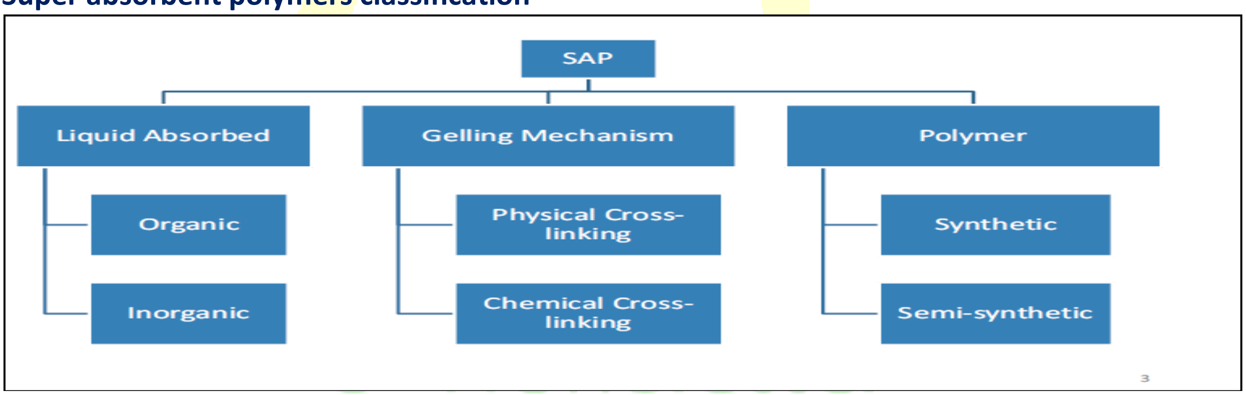
The area under dry land condition is 85 m ha (60% of total cultivated area), which receives average annual rainfall less than 1150 mm. Also, more than 30% of total geographical area of the country comes under low rainfall of less than 750 mm. India ranks 41st among 181 countries with regard to water stress. About 84 districts in India fall in the category of low rainfall area. Crop production in dry land agriculture is totally depend on amount and distribution of rainfall. Drought condition mainly affected on chlorophyll content, nitrate reductase activity, and relative water content in crop plants which reduce the photosynthetic capacity of crops.

What is super absorbent polymers?

First developed in 1970s by the USDA for applications in agriculture, Super Absorbent Polymers, also known as Hydro gel, Absorbent Polymer, absorbent gels, super slurpers *etc*.

"It is a new type of macro molecular synthetic water absorbing polymer material that absorb extra water in soil and protect the crop in rainy and dry season. SAPs are generally white sugar-like hygroscopic materials that swell in water to form a clear gel made of separate individual particles and can retain moisture even under pressure without risk of conflagration or rupturing/blasting."

Super absorbent polymers classification



Different types of chemical cross linking polymers

- It's can be classified into four groups based on the presence and absence of electrical charge located on the cross-linked chain :

1. Ionic
2. Non-ionic includes anionic and cationic groups
3. Amphoteric electrolyte, containing acidic and basic groups
4. Zwitter-ionic, containing both anionic and cationic groups in each repeating unit

Table 1. Salient features of Super absorbent polymers

Composition	Cross linked copolymer of acrylamide and potassium acrylate
Dry matter	85% - 90%
Specific weight	1.10 g/cm
pH	8.10
Particle size	Powders, micro granules, granules
Maximum absorption (in w/w)	400 in deionized water
Water retention capacity at pF 4.2	980 ml
Available water at pF 4.2 (near PWP)	95%
Cationic Exchange Capacity (CEC)	4.6 meq/g
Effectiveness in soil	Up to 5 years
Toxicity in soil	None under normal conditions of use
Storage temperature	**35** ^{0}C
Shelf Life of the dry product	5 years

General application process for agriculture Super absorbent polymers

- Generally, 1-2 kg SAPs is applied per acre. Apply the polymer under the soil at the depth of 4 to 8 inches in the root zone of the plants.
- In the crop field; first, prepare a mixture by adding 5 kg polymer to 10 kg of dry soil. Then the mixture would be applied along with seeds or fertilizer after sowing or in the furrow before sowing.
- In the nursery bed for transplanting; 2 gm of the polymer is used for every square meter and it should be used at the depth of 2 inches.

Table 2 : Suggested various dosage of SAPs under different condition.

Suggested dosage of SAPs	Recommendation for uses
4 to 6 grams/kg of soil	For arid and semi arid region
2.25 to 3.0 grams/kg of soil	For all level of water stress treatment and improved irrigation period
0.2, 0.4 and 0.8 % of soil	To delay permanent wilting point in sandy soil
2 to 4 grams/plant pit	To save irrigation water is up to 15 to 50 %
0.5 to 2.0 grams/plot	To improve relative water content and increased leaf water use efficiency
2.5 to 5.0 kg/ha	To prohibit the bad effect of drought stress

Water absorption mechanism of Super absorbent polymers

- The hydrophilic groups (acrylamide, acrylic acid, acrylate, and carboxylic acid *etc.*) of the polymer chain are responsible for water absorption in SAPs. The acid groups are attached to the main chain of the polymer.
- When these polymers are put in water, the latter enters into the SAPs system by osmosis and hydrogen atoms react and come out as positive ions. This leaves negative ions along the length of the polymer chain. Hence the SAPs now has several negative charges down its length. These negative charges repel each other. This forces the polymer chain to unwind and open up. They also attract water molecules and bind them with hydrogen bonding.
- SAPs can absorb more than 400 times its weight of water by this mode. When its surroundings begin to dry out, the SAPs gradually dispenses up to 95% of its stored water. When exposed to water again, it will rehydrate and repeat the process of storing water.
- This process can last up to 2–5 years, by which time biodegradable SAPs decomposes.

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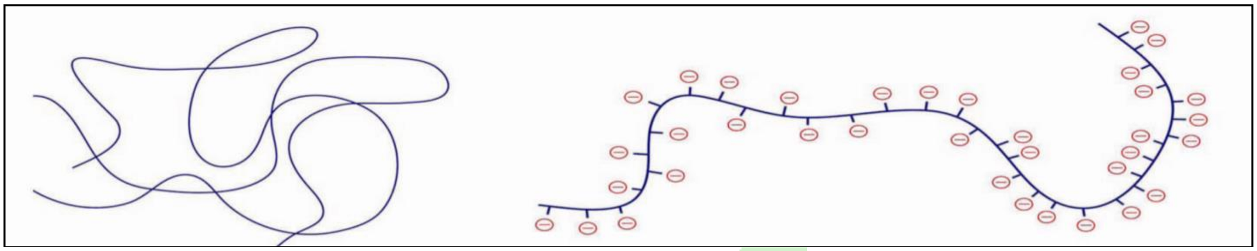
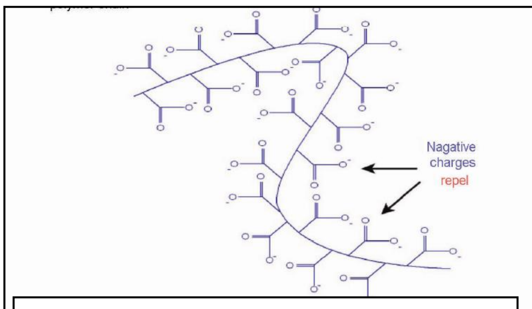
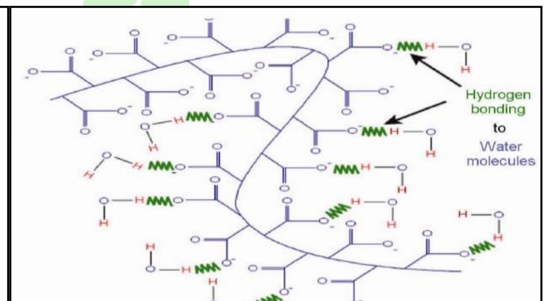




Before water contact : Coiled SAPs chain



After water contact : SAPs chain with several negative

- The total absorbency and swelling capacity are controlled by the type and degree of cross-linkers used to make the gel. Low-density cross-linked SAPs generally have a higher absorbent capacity and swell to a larger degree. These types of SAPs also have a softer and stickier gel formation. High cross-link density polymers exhibit lower absorbent capacity and swell, but the gel strength is firmer and can maintain particle shape even under modest pressure.

Effect on soil properties

- Soil amendment SAPs affects soil properties such as infiltration rate, bulk density, soil structure, compaction, soil texture, aggregate stability, crust hardness and evaporation rates.
- The saturated hydraulic conductivity of soil decreases significantly with an increase in mixing ratio and swelling properties of the SAPs. When SAPs swell in soil, it reduces large pores, especially in sandy soils.

SUPER ABSORBENT POLYMERS ARE ENVIRONMENT FRIENDLY

- Biodegradable SAPs contain labile bonds either in the polymer backbone or in the cross-links used to prepare the SAPs. The labile bonds can be broken under physiological conditions either enzymatically or chemically over a period of time. End-products after degradation are CO_2, water and ammonia.
- Acrylamide residue is also not detected in crop products which are grown with hydrogel application.

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- White-rot fungi such as *Phanerochaete chrysosporium,* could degrade polymers extensively and sometimes could degrade many compounds completely to CO_2 a process called mineralization.

WHAT IS PUSA HYDROGEL ?

Pusa hydrogel, a semi-synthetic super absorbent polymer which has been developed by the Indian agriculture research institute. It sticks to the roots of the plant and when the soil moisture falls as the temperature rises, the gel sheds water to nourish the crop.

What are the benefits of Super absorbent Polymers?

- Its help to prevent water loss in the soil.
- Reduce irrigation and fertilization frequency.
- Improve physical properties of soils and for every type of crop.
- Improve the microflora of soil.
- It upgraded soil nutrient and organic carbon status.
- Helps plants withstand prolonged moisture stress.
- Reduces nursery establishment period and increase the age of Plants.
- It can about extend 30-50 % irrigation cycle. It’s also necessary to consider the local soil characteristics and climate.
- It could reduce soil contamination by preventing pollutants from passing through the soil and thereby improving the quality of drainage water.

Table 5 : Agricultural hydrogel products available in India.

Trade name	Manufacturing company
Pusa hydrogel	IARI, New Delhi
Waterlock 93N	Acuro Organics Ltd, New Delhi
Agro-forestry water absorbent polymer	Technocare Products, Ahmedabad
True hydrogel	Chemtex Speciality Ltd, Mumbai
Rain drops	M5 Exotic Lifestyle Concepts, Chennai

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Simulation techniques, system analysis and modeling

Article id: 22952

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INTRODUCTION

Uncertainty ridden agriculture requires reliable and well-timed forecast of pests and diseases. To reduce the yield-loss, timely and need based application of remedial measures are indispensible. This is possible with the prior knowledge of the time and severity of the outbreak of pests and diseases So, factors affecting crop yield and infestation of pest and diseases need to be looked in to models can provide reliable forecast of crop yield in advance of harvest and also forewarning of pests and diseases attack so that suitable plant protection measures could be taken up timely to protect the crops.

Computer Model

• Models are ascribed from the real world system, models follows and involve similar components of real world system which help in giving clear details of functioning of different components of system.
• A computer-based model is a program that is designed to simulate what might or what did happen in a situation

Types of models

• Dynamic models consider changes with time
• Static models represent relations between variables which do not involve time.
• Empirical models are based on the direct descriptions of observed data and are generally expressed as regression equations. Decides on an equation or set of equations and fits them to data.
• Mechanistic models, explain not only the relationship between weather parameters and yield, but also the mechanism of these models
• Deterministic models estimate the exact value of the yield or dependent variable with defined coefficients.
• Stochastic models, a probability element is attached to each output. For each set of inputs different outputs are given along with probabilities.

• Optimizing models have the specific objective of devising the best option in terms of management inputs for practical operation of the system.
• Descriptive model defines the behavior of a system in a simple manner. The model reflects little or none of the mechanisms that are the causes of phenomena. It consists of one or more mathematical equations.

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• Explanatory models consist of quantitative description of the mechanisms and processes that cause the behavior of the system.

Simulation models

• Simulation modeling is the process of creating and analyzing a digital prototype of a physical model to predict its performance in the real world. One of the main goals of crop simulation models is to estimate agricultural production as a function of weather and soil conditions as well as crop management.

Model building

Various steps in model building may thus be distinguished:
(a) the conceptual phase or model,
(b) the comprehensive model and
(c) the summary model.

Within the conceptual phase, the following steps may be distinguished

1. Formulation of objectives
2. Definition of the limits of the system
3. Conceptualization of the system (states, rates and variables, etc.)

In the comprehensive modelling phase, steps 4 to 6 may be distinguished

4. Quantification through literature, process experiment or estimation of the relations between rate and forcing variables, state or auxiliary variables
5. Model construction (definition of the computer algorithm)
6. Verification of the model, i.e. testing the intended behaviour of the model. Finally, the model is used to set research priorities and to develop management tools
7. Validation, *i.e.* testing the model in parts or as a whole, using independent experiments on system level
8. Sensitivity analysis
9. Simplification, development of a summary model
10. Formulation of decision rules or forecasting models to be used in management.

These ten steps may be seen in any modelling effort, although very often incomplete or not exactly in this order.

Pre-requisites for the development of pest forecasting models

1. Quantitative seasonal studies which involves seasonal abundance and sampling of population
2. Life history and pest biology which involves life span, survival rate, food, intrinsic growth rate in field and laboratory
3. Ecological studies of the pest which includes life studies of the pest which is important for better understanding of pest population build up, natural mortality factors and critical stages
4. Crop phenology which includes different crop cultivars, fertilizer dosages, irrigation and plant spacing which influence the phenology of the crop
5. Natural enemies which involves the population of natural enemies present on various time intervals in the crop

6. Agro-ecosystem which involves changing cropping pattern and crop diversification involving different crops with a wide range of varieties of different maturity groups serve as suitable niche for supporting the buildup of pests.

Examples of various pest forecasting models around the world

1.MOTHZV-computer based simulation model

• A computer based simulation model MOTHZV has been developed for predicting the population dynamics of *Helicoverpa* species.

• The model uses early season number of eggs, larvae or adults to forecast the timing and size of later potentially damaging population.

• Pheromone trap has provided the means for measuring early season numbers of *Helicoverpa* adults.

• This trap data along with climatic variability and crop phenology are used to the MOTHZV model to predict the timing of future *Helicoverpa* generations.

APPLICATIONS OF SIMULATION MODELS IN PEST MANAGEMENT

1. Pest and disease resistance

• Transgenic plants may pose an element of risk when introduced for cultivation, but simulation models can predict the consequences of such introductions.

2. Rationalizing pesticide use: Determination of Economic injury levels (EIL)

3. Formulation of iso-loss curves

4. Pest risk analysis: These analyses the risk associated with introduction of exotic pests into new ecosystem.

5. Predictive pest zonation

6. Pest forecasting and decision making

7. Effect of climate change on pests and crops:

• This can be used to assess the impact of climate change on pest dynamics without associating with crop productivity.

• This include expansion of pests ranges, changes in population growth rates ,increased periods of activity, alterations in crop-pest synchrony, natural enemy pest interactions.

CONCLUSION: Timely forecast of pests and diseases and their associated climatic factors help to take up rational pest management practice, Even though the techniques involved and costs are high, models, with the help of mathematical equations analyze, predict and forewarn the pest out break and allow efficient integrated pest management strategies.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Importance of vermicompost

Article id: 22953

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INTRODUCTION:

Composting is a fundamental practice of organic gardening. Vermicomposting refers to the biological decomposition of organic wastes into a beneficial soil amendment with the help of some unlikely facilitators – earthworms that are more advantageous than traditional composting. Earthworms consume biomass and excrete it in digested form known as worm casts (also called black gold). These casts serve as rich source of nutrients, plant growth promoting substances and beneficial soil micro flora. Vermicompost could be prepared from the kitchen waste, farm waste, market waste, even from biodegradable city waste. From the Latin "vermi," which means worm, vermicompost offers nutrients that are immediately available to plants. It can be applied as mulch, incorporated as a component in potting mixes or brewed in water as a compost tea liquid fertilizer. Major advantages of vermicompost include improving soil health, increasing harvest yields and suppressing plant disease among others.

The Difference between Vermiculture and Vermicomposting

Vermiculture is the culture of earthworms. With the goal of continually increasing the number of worms in order to obtain a sustainable harvest, the worms are either used to expand a vermicomposting operation or sold to customers who use them for the same or other purposes Vermicomposting is the process by which worms are used to convert organic materials (usually wastes) into a humus-like material known as vermicompost.

Types of Earthworms used in vermicompost:

Epigeic: e.g. *Eisenia foetida* (Red earthworm), *Eudrilus engenie* (night crawler), *Perionyx exacavatus*
Endogeic: e.g. *Pentoscolex* spp., *Eutopeius* spp., *Drawida* spp.
Aneceic: e.g. *Polypheretima elongate*, *Lampito marutt* (Card *et al.,* 2004)
Red earthworm is preferred because of its high multiplication rate and thereby converts the organic matter into vermicompost within (45-50) days.

Method of vermicomposting:

(I) Bedding: Criteria of bedding material with the aim of providing the worms with a relatively stable habitat should be-

- **High absorbency:** The bedding must be able to absorb and retain water fairly well if the worms are to thrive.
- **Good bulking potential:** Different materials affect the overall porosity of the bedding through a variety of factors, including the range of particle size and shape, the texture, and the strength and rigidity of its structure. The overall effect is referred to in this document as the material's bulking potential.
- **Low protein and / or nitrogen content** (high Carbon:Nitrogen ratio): High protein/nitrogen levels may cause rapid degradation and its associated heating, creating inhospitable, often fatal, conditions.

(II) Pit method: Composting is done in the cemented pits of size (5x5x3) feet. The unit is covered with thatch grass or any other locally available materials. This method is not preferred due to poor aeration, water logging at bottom, and more cost of production.

Steps of vermicomposting: (Nagavallemma *et al.,* 2004)

- Vermicomposting unit should be in a cool, moist and shady site
- Cow dung and chopped dried leafy materials should be mixed in the proportion of 3: 1 and are kept for partial decomposition for (15–20) days.
- A layer of (15-20) cm of chopped dried leaves/grasses should be kept as bedding material at the bottom of the bed.
- Beds of partially decomposed material of size (6x2x2) feet should be made
- Each bed should contain (1.5-2.0) q of raw material and the number of beds can be increased as per raw material availability and requirement.
- Red earthworm of (1500-2000) in numbers should be released on the upper layer of bed.
- Water should be sprinkled immediately after the release of worms.
- Beds should be kept moist by sprinkling of water (daily) and by covering with gunny bags/polythene.
- Bed should be turned once after 30 days for maintaining aeration and for proper decomposition.
- Compost gets ready in (45-50) days.
- The finished product is 3/4th of the raw materials that were used.

Table-1: Comparison of Nutrient composition of vermicompost and garden compost:

Nutrient element	Vermicompost (%)	Garden compost (%)
Organic carbon	9.80 - 13.40	12.2
Nitrogen	0.51 - 1.61	0.80
Phosphorus	0.19 - 1.02	0.35
Potassium	0.15 - 0.73	0.48
Calcium	1.18 - 7.61	2.27
Magnesium	0.093 - 0.568	0.57
Sodium	0.058 - 0.158	<0.01
Zinc	0.0042 - 0.110	0.0012

Copper	0.0026 - 0.0048	0.0017
Iron	0.2050 - 1.3313	1.1690
Manganese	0.0105 - 0.2038	0.0414

Source: Adhikary (2012)

Advantages of vermicompost: (Vennila *et al.,* 2012)

- Vermicompost is rich in all essential plant nutrients. So it improves soil organic matter and nutrient status.
- It contributes positive effect on overall plant growth and improves the quality and shelf life of the produce.
- The free flowing nature of vermicompost makes it easily applicable. Handling and storage are also easy.
- Vermicompost is rich in beneficial micro flora such as a fixers, P- solubilizers, cellulose decomposing micro-flora etc in addition to improve soil environment.
- It prevents nutrient losses and increases the use efficiency of chemical fertilizers.
- Vermicompost is out of danger because it is free from pathogens, toxic elements, weed seeds etc.
- It contains valuable vitamins, enzymes and hormones like auxins, gibberellins

Drawbacks of vermicompost:

- Labour consuming
- It requires more space because worms are surface feeders and won't operate in material more than a meter in depth
- It is more vulnerable to environmental pressures, such as freezing conditions and drought
- Perhaps most importantly, it requires more start-up resources, either in cash (to buy the worms) or in time and labour (to grow them).

Precautions to be taken while preparing vermicompost:

- Proper temperature of (8-30) °C and humidity should be maintained inside the bed. To mainatain proper moisture (70-80%) sprinkling of water should be done at 2-3 days interval.
- Earthworms should be protected from natural enemies like frogs, snakes, birds, crow, lizard and ant.
- Care should be taken that there should not be any outbreak of termites and red ant inside the bed.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

CONCLUSION

In recent years, the ecological characteristics and beneficial effects of earthworm have been clearly understood and focused by scientific research. It serves as an alternative approach of better waste management than by both land-filling and burning. Resource recycling is possible in sustainable manner. The nutritive value of compost material is high and the composting process effectively converts the waste product into useful by-product. In this sense, vermicomposting with sound environmental principles is highly recommended.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Use of yeast as a biocontrol agent

Article id: 22954

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INTRODUCTION:

Yeasts are eukaryotic micro-organisms classified in the kingdom Fungi, with the 1,500 species currently described estimated to be only 1% of all yeast species. Most reproduce asexually by budding, although a few do so by binary fission. Yeasts are unicellular, although some species with yeast forms may become multicellular. Yeast size can vary greatly depending on the species, typically measuring 3–4µm in diameter, although some yeasts can reach over 40 µm. It is also extremely important as a model organism in modern cell biology research, and is one of the most thoroughly researched eukaryotic microorganisms. Other species of yeast, such as *Candiada albicans*, are opportunistic pathogens and can cause infections in humans. Yeasts have recently been used to generate electricity in microbial fuel cells and produce ethanol for the biofuel industry. Yeasts do not form a single taxonomic or phylogenetic grouping. The term "*yeast*" is often taken as a synonym for *Saccharomyces cerevisiae*, but the phylogenetic diversity of yeasts is shown by their placement in two separate phyla, the Ascomycota and the Basidiomycota. The budding yeasts ("true yeasts") are classified in the order Saccharomycetales.

History:

The word "yeast" comes to us from Old English *gist*, *gyst*, and from the Indo-European root *yes-*, meaning *boil*, *foam*, or *bubble*. Yeast microbes are probably one of the earliest domesticated organisms. People have used yeast for fermentation and baking throughout history. In 1680 the Dutch naturalist Anton van Leenuwenhoek first microscopically observed yeast, but at the time did not consider them to be living organisms, but rather globular structures. In 1857 French microbiologist Louis Pasteur proved in the paper "*Mémoire sur la fermentation alcoolique*" that alcoholic fermentation was conducted by living yeasts and not by a chemical catalyst. Pasteur showed that by bubbling oxygen into the yeast broth, cell growth could be increased, but the fermentation inhibited an observation later called the "Pasteur Effect". By the late 18th century, two yeast strains used in brewing had been identified: *Saccharomyces cerevisiae*, so called top fermenting yeast, and S. carlsbergensis, yeast.

Classification of Yeast:

Kingdom	:	Fungi
Phylum	:	Ascomycota
Subphylum	:	Saccharomycotina
Class	:	Saccharomycetes
Order	:	Saccharomycetales

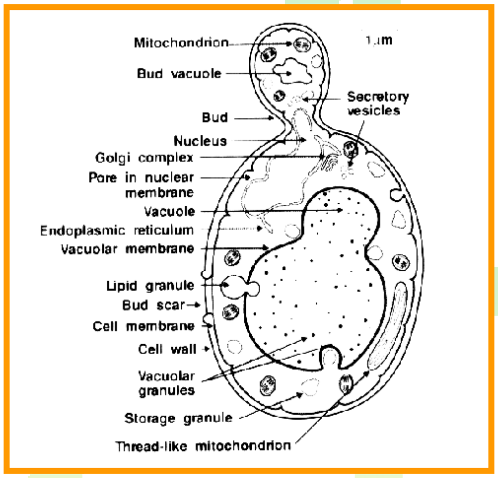
Family	:	Saccharonycetaceae
Geneus	:	Saccharomyces
Species	:	*cerevisiae*

(Binomial name *Saccharomyces cerevisiae* Meyen ex. E.C. Hansen)

Structure of the Yeast cell:

The shape of yeast cell is oval to round with a length of 5-8 micron. You can only see the yeast cell under a microscope. The compositions inside the yeast cell are following:

- Mitochondrion
- Bud Vacuole
- Bud
- Necleus
- Golgi complex
- Pore in nuclear membrane
- Vacuole
- Thread-like mitochondrion
- Secretory vesicles



- Endoplasmic reticulum
- Vacuolar membrane
- Lipid granule
- Bud scar
- Cell membrane
- Cell wall
- Vacuolar granules
- Storage granule

Different species of yeast: *Cryptococcus laurentii, Candida ciferrii*, *Candida musae*, *Saccharomyces unispora*, *Candida steatolytica*

Reproduction of Yeast:

1. Budding
2. Conjugation
3. Spore

Yeasts have asexual and sexual reproductive cycles. The most common mode of vegetative growth in yeast is asexual reproduction by budding. Here a small bud, or daughter cell, is formed on the parent cell. The nucleus of the parent cell splits into a daughter nucleus and migrates into the daughter cell. The bud continues to grow until it separates from the parent cell, forming a new cell.

Some yeasts, including *Schizosaccharomyces pombe*, reproduce by binary fission instead of budding. Under high stress conditions haploid cells will generally die, however under the same conditions diploid cells can undergo sporulation, entering sexual reproduction (meiosis) and producing a variety of haploid spores, which can go on to mate (conjugate), reforming the diploid.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Biological Control

What is Biocontrol?

Biological control or biocontrol is the use of an invasive paint's natural enemies-agents (chiefly insects, parasites and pathogens) to reduce its population below a desired level. It is the long-term, self-sustaining treatment method for managing plant disease.

Classical Biocontrol :

This method uses natural predators of the invasive paint to establish a long-term balance between the biological control organism and the plant.

Inundative Biocontrol:

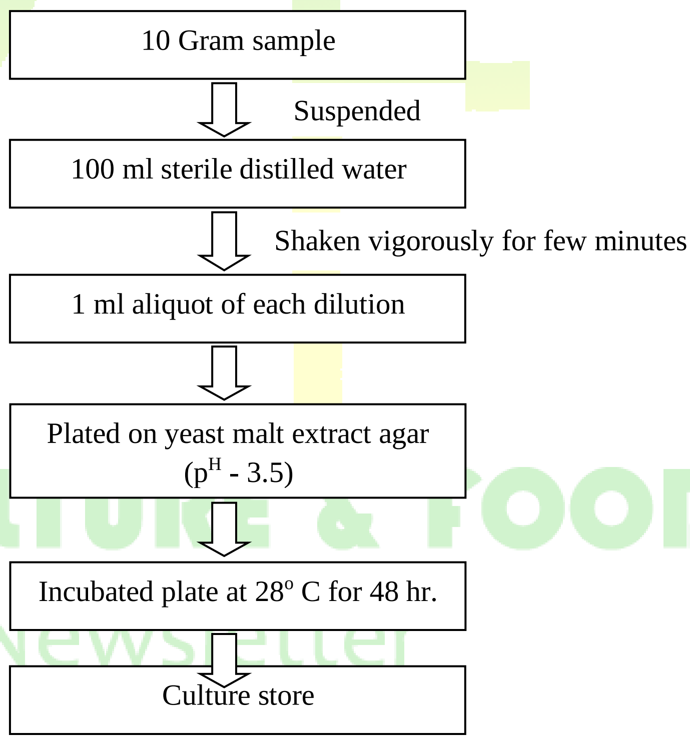
Typically uses pathogens, such as rusts and nematodes that are applied to the target weed at high rates in a manner similar to herbicide application.

Use of Biocontrol Agent:

Biocontrol is the only long-term solution for management of disease plant.

Over time, when using biological control, other treatment methods become decreasingly necessary, and may eventually not be needed. It is desirable to decrease the amount of herbicide applied to the environment (or potentially applied in the future) and to decrease economic losses and costs for control.

Yeast isolation



Use in Research:

- It is readily available and easy to culture; baker's yeast has long been used in chemical, biological, and genetic research. In 1996, after 6 years of work.
- *S. cerevisiae* became the first eukaryotic to have its entire genome sequenced, it has over 12 million base pairs and around 6000 genes.
- Most of our knowledge of the cell division cycle was worked out from experiments with yeast.
- Baker's yeast contains enzymes which can reduce a carbonyl group into a hydroxy group in fairly high yield, thus making it a useful bio-reagent in chemical synthesis.
- Baker's yeast can also be used to produce ethanol via fermentation for use in chemical synthesis,

Bio-control activity of two yeast strains from against blue mold of apple:

Two yeast antagonists, *Cryptococcus laurentii* (strain 317) and *Candida ciferrii* (strain 283) isolated from the surface of healthy apples, controlled blue mold of apple caused by *Penicillium expansum*. Both antagonists reduced the incidence of blue mold by 80% at 25 °C. At 5 ^{0}C *C. ciferrii* (strain 283) maintained the efficacy of disease control, but *C. laurentii* (strain 317) only reduced disease incidence by 50%. *C. ciferrii* (strain 283) exhibited significant protection at lower concentrations than *C. laurentii* (strain 317). The population of both strains increased in wounds of apples at 25 and 5 °C, and both strains maintained viable over a period of 35 days at 5 °C. Nutrient competition into wounds appeared to be the principal mode of action of these antagonists. Further research will explore commercial potential of these antagonists and the possibility of enhancing biocontrol efficacy by using mixtures of antagonists or additives such as calcium chloride or deoxyglucose.

Yeast Fungi as Biocontrol Agents for Wilt disease of Kidney Bean Caused by *Fusarium oxysporum*

The investigation was conducted to study the potential of rhizosphere yeast fungi for biocontrol of plant pathogenic fungi and to find alternatives to the use of chemicals for disease control in order to avoid environmental pollution.Two species of rhizosphere yeast fungi; *Saccharomyces unispora* and *Candida steatolytica* have antagonistic Yeast inhibitory effects on the growth of the fungal pathogen *Fusarium oxysporum*. These two species to the soil seeded with kidney bean and infested with the pathogen increased the percentage of control plants. It was noticed that the two tested species of yeast fungi increased kidney bean growth measurements (fresh and dry weights of root and shoot, length of root and height of shoot) compared to infected and non-infected plants. Four active components were detected in the culture filtrates of both *Saccharomyces unispora* and *Candida steatolytica* which were found to be inhibitory to *Fusarium oxysporum*.

Table 1 : Antagonistic activity of yeast fungi against Fusarium

Yeast fungi	*Fusarium oxysporum*
	% of inhibition
Saccharomyces unispora	65
Candida steatolytica	70

Source : Arras, G., 1996

Table 2 :Effect of yeast fungi on both the germination of kidney bean seeds and Pathogenicity of tested pathogenic fungus

Treatment	% of seed germination	Kidney bean % of diseased	% of control
Control	90	-	-
Pathogen only	22.5	77.5	-
S. unispora + pathogen	70	22.5	77.5
C. steatolytica + pathogen	80	11.5	88.5

Source : Deman S., 1993

Table 3 : Effect of the two yeast fungi on the growth measurements of the infected kidney bean

Treatment	Length of shoot	Height of plant	Fresh weight of root	Fresh weight of shoot	Dry weight of root	Dry weight of shoot
Control	10.14	22.2	0.44	4.23	0.17	0.53
Pathogen only	5.22	9.93	0.23	2.04	0.04	0.28
Saccharomyces unispora + pathogen	17.6	25.77	1.55	7.59	0.4	7.71
Candida steatolytica + pathogen	18.14	27.5	1.64	9.38	0.53	4.32

Source : Agblor S., 2001

Post harvest disease control by yeast in Chilli:

- Anthracnose caused by *calletotrichum capsici* is a major disease of tropical vegetable such as chilli.
- Yeast antagonistic to *collectotricum capsici* were isolated from fruits and vegetables.
- Four antagorists were found that inhibited *C. capsici* grouth with biocontrol efficacies. Antagonists are *pichia gulliermondii, candida musae, Issatchenkia orientalis, Candida quercitrusa.*

- In order to their efficacy, *P. guilliermondii* showed efficacy in reducing diseases incidence on *C. capsici* infected chilli fruits to as low as 6.5%.
- Lower disease incidence was observed at lower storage temperature.
- The application of *P. guilliermondii* is more effective for preserving chilli fruits than conventional preservation with chlorinated water.

Table 4 : The effectiveness of the four antagonistic yeast strains in reduction of disease (anthracnose) incidence in *Colletotrichum capsici* infected chilli fruits

Yeast isolate	Disease incidence (%)	Biocontrol efficacy (%)	Lesion diameterb (mm)
Pichia guilliermondii	6.7 ± 0.40	93.3 ± 0.40	6.7 ± 0.23
Candida musae	16.9 ± 0.87	83.1 ± 0.87	7.8 ± 0.17
Issatchenkia orientalis	23.4 ± 0.92	76.6 ± 0.92	9.1 ± 0.28
Candida quercitrusa	33.6 ± 0.52	66.4 ± 0.52	10.3 ± 0.35
Control	100.0 ± 0.00	0.0 ± 0.0	15.4 ± 0.40

Source : Agblor S., 2001

Yeast as bio control agent on fruit crops

- Post harvest losses of fruits and vegetables are high, ranging from10-40% depending on the species and technologies used in the packing houses.
- Such losses are mainly due to pathogenic fungi which usually effects the host through wounds made during harvest, handling and processing.
- In apples, post harvest losses are mainly causes by *penicillium expansum*.
- It was discovered that *Cryptococcus laurentii* has antagonistic activity against many post harvest pathogens.
- Decay caused by *Rhizopus* species is reduced 70% when strawberries are with *Aureobasidium pullulans* before storage.
- It was found that *Rhodotorula glutinis* produced rhodatorulic acid which enchanced biocontrol activity of *Rhodotorulic glutinis* against *penicillium expansum* in post harvest apples.

CONCLUSION

- Yeast are used for biological control in most post harvest diseases in fruits and vegetable.
- The biocontrol efficacy of *Cryptococcus* species was superior.
- The two yeast fungi species significantly increased the percentage of inhibition of disease caused by the pathogen *(F. oxysporum).*
- Yeast showed efficacy in reducing diseases incidence on *C. capsici* infected chilli fruits to as low as 6.5%.
- Decay caused by *Rhizopus* species is reduced by 70%.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Lac based agroforestry models for prosperity of farmers in Jharkhand

Article id: 22955

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Most farming families have adopted traditional farming systems such as plantations, homegardens and other practices like Sericulture and Lac cultivations as mean of their livelihoods. In Jharkhand, Lac production is mainly associated with various host plants which are mostly found in forest areas. However, new technologies have made it possible to adopt it for cultivation as well. Outcome of many researches and findings revealed that, Lac based agroforestry system has the potential to use the free time of the farmer, generate additional employment and get additional income. Thus, there is a huge scope to the Lac growers to improve their livelihood by adopting science, technologies and rural innovations; but at the same time, they can preserve and maintain the green cover of the earth.

INTRODUCTION

The supply of food, timber, firewood, fodder for animals and other NWFPs (Non-wood Forest Products) by agroforestry can not only improve the livelihood level of the people but also help in reducing the damage caused by climate change. Conventionally, trees are considered as agents to improve nutrient cycling and retention in agricultural ecosystems by performing a number of functions that helps in conservation of natural resources. Eastern region of India is about 22% of the total geographical area, but it maintains 34% human population and 31% livestock (Das *et al.,* 2016). This area is spread over eastern Uttar Pradesh, Bihar, Jharkhand, Odisha, Chhattisgarh, West Bengal and Assam state. The part of the total area is under forest, which mostly caters to the need of biomass of tribal and non-tribal families which in long run leads to deforestation and environmental degradation (Das *et al.,* 2016; Sarkar *et al.,* 2017a, b & c; Shinde *et al.,* 2017; Das *et al.,* 2019a & b; Sarkar *et al.,* 2019a & b; Shinde *et al.,* 2019a & b; Sarkar, 2019). Hence, efforts should also be made to rehabilitate outside forest areas through agroforestry interventions so as to meet out the fuel, fodder and timber requirements on the one hand and to enhance area under forest cover on the other.

Farming system approach of land use must be replicated throughout the region with special emphasis on tribal farming systems, which are, by and large, ecologically and economically viable. This will ultimately help in increasing the forest area. Moreover, various agroforestry models including Lac based systems can be adopted to gain more profits by tribal farmers. Moreover, agroforestry has been practiced as traditional land use and livelihood option in Jharkhand since time immemorial. The 4.21 % of the total geographical area of Jharkhand is under tree green cover in agroforestry. Comparing the other states of eastern region, it has the highest area under wastelands (14.84%). Hence, there are scopes to intervene various agroforestry practices at the barren wastelands/degraded lands/ waterlogged areas under rain-fed condition (Sarkar *et al.,* 2019c & d), keeping in view the average size of land holdings for agricultural production besides fuel, fodder and timber requirements of rural folk.

Features of agroforestry system

Soil productivity can be increased or maintained by choosing appropriate crops in agroforestry (Sarkar and Yadav, 2019). Following are some of the features of agroforestry:
1. Multipurpose trees/ woody plants should be selected for agroforestry.
2. There should be more than one farming component on the same land unit including forestry component.
3. Crops should be planted in multi-story or multi-tiered systems in such a way that there is less competition among plants for water, nutrients, sunlight and air.
4. Farmers should get regular income from this system.

Benefits of agroforestry

The following are the main benefits of agroforestry:
1. Reduces pressure on forest and preserves ecosystem.
2. Increases biological diversity by providing a favorable environment.
3. Increases recycling of nutrients at different depths within the soil.
4. The nutrient fixing component keeps the nutrients in the soil balanced.
5. Adding organic material to the soil improves its structure.
6. Reduces the total crop failure.
7. Increases production in unit area.
8. Brings overall improvement in livelihood, health and standard of living of rural people.

Traditional Agroforestry System of Jharkhand

Homestead gardens and scattered trees (like Acacia, Palas, Mahua, *etc.*) on agriculture fields, are some of the traditional agroforestry systems in Jharkhand. Under the agri-horticultural systems, fruit trees are planted on the field bunds in addition to crops. Cultivation of Lac, is a prevalent practice in the state but agrisilviculture with Lac cultivation is the most important agroforestry system being in their common practice. Kusum (*Schleichera oleosa*), Palash (*Butea monosperma*), Ber (*Zizyphus mauriatiana*) and hedge species like *Flemingia semialata* are the most suitable plants for Lac cultivation in the Agrisilvicultural system in Jharkhand (Sarkar *et al.,* 2017a & b).

For the livelihood improvement of the tribal farmers of the state, Lac-based integrated farming system model having components like Lac host, fruit plant and vegetable crops, had already been recommended. Lac worth rupees (₹.) 600 were received in a year from a plant of Palash. More than 400 lakhs of host plants are found all over the world (Sharma *et al.,* 2006). The trees like Kusum (*Schleichera oleosa*), Palas (*Butea monosperma*), Ber (*Zizyphus mauritiana*) and *Ficus* spp. account for about 90 per cent of total Lac production in the country as host plants. It has been found that Lac cultivation is beneficial for upliftment of socioeconomic status of farmers because of income generation. Gum yielding trees species such as *Acacia Senegal* (gum Arabic) and *Boswellia serrata* (guggul gum) are having scope to introduce as potential species for agroforestry models in Jharkhand.

Lac based agroforestry model

Some Lac based agroforestry models are mentioned below:

1. *Flemingia semialata* + Papaya + Mango:

Planting of *Flemingia* plant can be done in paired row of 0.75 m distance and plant to plant distance 1.0 m. It should be planted in a triangular pattern. A distance of 2.0 meters should be maintained between its two pairs of rows in which a fruit plant can be planted. In this model, a total of 7200 *Flemingia* plants per hectare can be planted. The fruit plant can be planted in a ratio of 2:1 (Papaya : Mango), in which each papaya plant will be at a distance of 2 meters. The distance from mango to mango will be 4 meters. A total of 1200 papaya plants and 600 mango plants per hectare can be planted. After one year of planting, the *Flemingia* plant gets ready for Lac cultivation. The economic yield explains that this model is profitable with the B:C ratio of 3.65 during first year (Kumar, 2013).

2. *Flemingia semialata* + Papaya + Mango + Kusum:

In this model, a total of 7200 ***Flemingia***, 900 papaya, 450 mango and 450 Kusum can be planted in one hectare. The plant can be planted in a 2:1:1 ratio (Papaya : Mango : Kusum) with a distance of 2 meters between each row. Papaya plants will be 4 meters apart while the distance from mango to mango and Kusum to Kusum will be 8 meters (Kumar, 2013). The model has three components of income generation such as Lac, fruit and vegetable. This model is profitable from the first year itself (B:C ratio is 3.26 in the first year).

3. *Flemingia semialata* + Papaya + Mango + Kusum: In this model, a total of 5400 individuals of *Flemingia*, 433 papaya, 433 mango and 433 Kusum can be planted in one hectare. Income will start after three months with vegetable cultivation. The plants of *Flemingia* will be ready after one year for Lac inoculation in the month of July. The plant can be planted in a 1:1:1 ratio (Papaya : Mango : Kusum), with a distance of 2 meters between each row (Kumar, 2013).

Each similar species, papaya to papaya, mango to mango and Kusum to Kusum will be at a distance of 6 meters and alternate position in each row. Each line will be at a distance of 3.75 meters. It was reported that, the model has three components of income generation such as Lac, fruit and vegetable. This model is also profitable (B:C ratio of 2.68 during the first year), but is lower than the other two models as mentioned above.

4. *Flemingia semialata* + palas (*Butea monosperma*) + ber tree:

To promote livelihood opportunities for farmers, CAFRI introduced Lac-based farming system for Palash and ber trees for the semi-arid Bundelkhand region (Tewari *et al.*, 2013). Similar models are also being very widespread in the farmer's field of Jharkhand.

5. *Flemingia macrophylla* + *Dalbergia Sissoo*: An earlier experiment conducted on mean performance for height in *Flemingia macrophylla* showed that, in the control or open conditions (229.94 cm), there was almost twice the height of the plants grown compared to the shady condition (132.98 cm). The average 'scrap Lac' yield from the Aghani, Jethwi and Katki crop was reported as 166.64 g/plant, 105.36 g/plant and 81.47 g/plant, respectively, compared to the under-story method (63.63 g/plant, 27.58 g/plant and 17.00 g/plant, respectively).

Other systems

A) In some areas of Jharkhand, agroforestry systems like *Jatropha curcus* based, Lac cultivation based, gum yielding trees *etc*., through which farmers are earning a huge revenue that helps to strengthen their socio economic status.

B) In 0.42 hectare model of integrated farming systems (IFS) developed for each of the combinations *viz.,* Paddy + Lac + Fishery + Goat, Paddy + Vegetables + Lac + Duckry + Goat + Buffalo, Paddy + Vegetables + Lac + Goat + Cow + Poultry, and Paddy + Vegetables + Lac + Poultry + Cow yielded an annual net profit of ₹. 88,770 (B:C ratio of 7.39), ₹. 63,400 (B:C ratio of 5.04), ₹. 85,909 (B:C ratio of 7.81) and ₹. 65,090 (B:C ratio of 3.32), respectively. Whereas, from the IFS model of 1.25 hectares, the three farming system combinations, *viz.,* Paddy + Vegetables + Lac + Poultry, Paddy + Vegetables (potato and tomato) + Lac + Poultry, and Paddy + Vegetables + Lac + Goat + Buffalo had received an annual return of ₹. 1,02,000 (B:C ratio of 4.34), ₹. 1,08,440 (B:C ratio of 5.96) and ₹. 80,700 (B:C ratio of 7.34), respectively.

C) Palas (*Butea monosperma*) + Paddy based agroforestry system: It had also been reported that, the species, Palas has been planted on the ridge of the field in different parts of central India along with paddy crops, for cultivation of Lac which usually yields an annual return of ₹. 800 per tree.

Management of Agroforestry

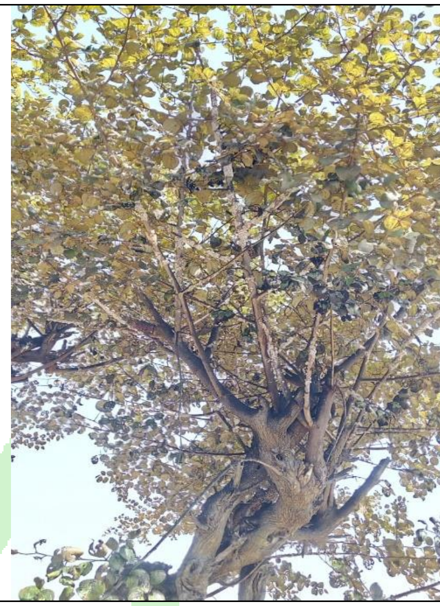
The farmer should have adequate knowledge on various aspects of agroforestry. Otherwise, training programme should be organized for the farmers from time to time. The farmer should especially be aware of the following aspects:

1. Host plants and the specific Lac producing insects
2. Season based Lac production technologies
3. Plant management techniques such as planting time, weed control, keeping the plantation cleaned, management of plant canopy by pruning, pest management, harvesting, processing, *etc.*

CONCLUSION

By adopting Lac based agroforestry models, the farmers can use their free time to get additional income and can generate additional employment. Thus, there is a huge scope to Lac growers to improve their livelihood by adopting science, technologies and rural innovations.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

	
Distribution of broodlac to farmers	Lac cultivation on Ber (*Zizyphus mauriatiana*)

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Modern Beekeeping Equipment's

Article id: 22956

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INTRODUCTION:

Beekeeping is an art and a mesmerizing science. In India beekeeping is mostly practiced as a full-time occupation and an engrossing hobby to produce handsome income and table honey. Honeybees are special gift to mankind because beekeeping can be done for both their pollination services and their cherished products such as honey, beeswax, propolis, bee venom, etc. These are the equipment's which is important for bee keepers.

Smoker:

The smoker is a metal cylinder in which smoke is produced by igniting fire. The smoker is attached with a bellow to blow air into the fire. The regulated smoke that comes out of the nozzle is directed into the hive to make the bees docile and less prone to stinging.

Honey Extractor:

It consists of a metal drum with a centrifugally rotating device, for the extraction of honey from the frames. Four frames filled with honey from the super chamber can be placed in the extractor at one time to extract honey by rotating it with the help of a handle, and the honey gets dislodged through a pipe attached at the bottom of the extractor, and the honey can be collected in jar, cylinder, etc. The use of the extractor does not cause any damage to the combs, and they can be placed back in the super chamber after honey extraction. Two-frame extractor is also available in which only two frames can be placed at a time; it will be helpful for small-scale and household beekeeping.

Comb Foundation Sheet:

In nature, bees build new combs from beeswax secreted by them and make parallel combs which are attached to the ceiling of the cavity or box. The combs may be built in the direction of the entrance, at right angles to it or in an oblique fashion. In the movable frame hive, it is imperative that straight combs be built in the frames so that when shifted from hive to hive, they may maintain the correct bee space between them. These comb foundation sheets are prepared by using comb foundation mill which uses wax sheets. These comb foundation sheets will save the energy of honeybees for building their combs as we are providing the basement.

Decapping Knife:

Honeybees seal the cells in honeycomb once the honey is stored in it, so for extracting the honey by using extractor, we have to decap the sealed portion by means of decapping knife. The decapping knife may be a normal plain steel knife or an electric heated knife.

Hive Tool:

It is a piece of flattened iron with hammered down edges and is used for prying apart the frames in the hive and for scraping bee glue and superfluous pieces of comb from the various parts of the hive.

Bee Veil:

It is worn over the face for protection against stings. It should be made of black light material such as nylon nettings so that we can get a better picture. Veils should be made to fit snugly around the hat and to fit tightly to the shoulder leaving enough space between the veil and face.

Gloves:

They give much protection as the honeybees mostly sting on the fingers and hands while handling them. They may be made of heavy canvas or rubberized cloth and are useful for beginners to develop confidence.

Bee Brush:

A bee brush or a whisk broom is often employed to brush off bees from honeycombs before it is used for honey extraction.

Feeders:

Various kinds of feeders for feeding sugar syrup to bees are used by beekeepers. The division board feeder, a wooden trough of the regular frame dimensions with shoulders so made that it may hang in the hive just like any other frame and with a wooden strip to serve as a float, is a useful appliance. A sugar syrup filled tin with holes in the lid is also a good type of feeder.

Queen Cell Protector:

It is a cone-shaped structure made of a piece of wire wound spirally. It fits around a queen cell. A queen cell which may have to be introduced from a queen right to a queenless colony is often protected in a queen cell protector until its acceptance by the bees.

Dummy or Division Board:

It is a wooden partition which serves as a movable wall and helps to reduce the size of the brood chamber so that bees can keep the hive air conditioned and well protected from bee enemies or inclement weather.

Embedder:

It is a small tool with a spur or round wheel on the top. It is used to fix the comb foundation sheet on the wires of the frame. Electric wire is also used for this purpose which is useful to reinforce the comb and give extra strength to the comb.

Drone Trap:

It is a rectangular box with one side open. The other side is fitted with queen excluder sheet. At the bottom of the box, there is a space for movement of worker bees. There are two hollow cones at the bottom wall of the box. Drones entering through the cones into the box get trapped. The narrow end of the cone is wide enough to let the bees pass out but not large enough to attract their attention or re-entry. This device is used at the entrance to reduce the drone population inside the hive.

Pollen Trap:

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Pollen-trapping screen inside this trap scrapes pellets from the legs of the returning foragers. It is set at the hive entrance. The collected pollen pellets fall into a drawer type of receiving tray.

Fig. 1: Beekeeping tools

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Present status and future strategies for increased pulse production in India

Article id: 22957

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INTRODUCTION

Agriculture plays a vital role in India's economy. 54.6% of the population is engaged in agriculture and allied activities (census 2011) and it contributes 17.4% to the country's Gross Value Added for the year 2016-17 (at current prices). As per the land use statistics 2014-15, total geographical area of the country is 328.7 million hectares, of which reported net sown area is 140.1 million hectares and the gross cropped area is 198.4 million hectares with a cropping intensity of 142 percent. The net area sown works out to be 43 percent of the total geographical area. The net irrigated area is 68.4 million hectares. Of the total net sown area of 141.40 million hectares, 52 per cent i.e. 73.20 million hectares is rain fed. The rain fed regions of the country support 40 per cent of human population and 2/3rd of livestock. As high as 90% of nutri-cereals (millets), 80% pulses, 74% oilseeds, 65% cotton and 48% rice crops are rain fed. However, the levels of uncertainty growth are still high due to vagaries of the weather and the fact that 52 percent is still un-irrigated and rain-fed.

Pulses have been a secondary choice in India after cereals, mostly confined to the rain fed ecology. More than 80% of total pulses are grown in this rain fed region. The production of pulses to the tune of 25.23 million tonnes during 2017-18 is close to self sufficiency in pulses. The country is now confident of meeting the projected demand of 35 million tonnes by 2030. Pulses, historically vital constituent of cropping and consumption pattern are the only rich source protein (20-25%) for 43 percent vegetarians (Urban – 48%, rural – 41%). Besides the double the protein content of wheat and three times that of rice, food legumes tend to fix 72 to 350 kg per ha per year atmospheric nitrogen to N-compounds to soil. With the twin objectives i.e. achieving food and nutritional security vis-à-vis enhancing income of the rain-fed farmers, the potential of pulses should be harnessed.

Different pulse production scenarios

During 2017-18, pulses were cultivated over > 29 million ha (Mha) of area and recorded the highest ever production of 25.23 million tonnes (Mt) at a productivity level of 841 kg/ha which is lower than world average. Gram occupies first position in pulse production. Arhar remained at 2nd position in total pulse production with 4.25 Mt of production in an area of 4.43 Mha at a productivity level of 960 kg/ha, the ever highest yield. Black-gram, the 3rd important crop group, was cultivated over an area of 5.44 Mha (kharif + rabi) and recorded a production of 3.56 Mt at a productivity level of 655 kg/ha. Similarly Green-gram was sown over an area of 4.26 Mha in (kharif + rabi) and recorded a production of 2.01 Mt at and yield level of 472 kg/ha.

Lentil also recorded an ever highest production of 1.61 Mt from area of 1.55 Mha at a productivity level of 1034 kg/ha, the ever highest yield level.

Pulses in Indian Context

- Pulses are an important group of food crops that can play a vital role to address national food and nutritional security and also tackle environmental challenges.
- The share of pulses to total food grain basket is around 9-10 per cent and is a critical and inexpensive source of plant-based proteins, vitamins and minerals.
- Pulses are critical in food basket, rich source of protein (@20-25 per cent, it is double the protein content of wheat and thrice that of rice) and help address obesity, diabetes malnutrition etc.
- In India, pulses are generally produced in poor soils not suited to other crops, with a minimum use of resources and have a very low water footprint. They are vital constituent of cropping and consumption pattern. The pulse cultivation occupies major area under this ecology.
- Pulses play a greater role in sustaining the economy of the rain fed farming community in a variety of ways. Besides improving soil fertility and physical structure, pulses fit well in mixed/inter-cropping systems, crop rotation and dry farming, provide green vegetable (pods/beans) and nutritious fodder for cattle as well thereby contributing to a more sustainable food system.
- Cultivation of pulses builds-up a mechanism to fix atmospheric nitrogen to N-compounds in their root nodules and tend to fix 72 to 350 kg N per ha per year, thereby meeting their own nitrogen requirements to a great extent.

Agronomic management for higher production

- **Selection of crops and varieties:** should be decided on the basis of duration of crop, temperature, soil texture, soil moisture content etc. (In lentil and gram, small seeded varieties due to better contact with soil, less rotting be selected).
- **Seed priming and optimum seed rate:** Overnight soaking of seeds (seed priming), hastens seed germination and crop establishment under relay cropping. Adoption of 20-25% higher seed rate over the recommended rate is recommended ensures desired plant stand.
- **Planting strategy:** In rice fallows, planting is generally delayed. Under relay planting, seeds should be broadcast 2-5 days before harvest of rice. Zero-till seed-cum-fertilizer drill should be used wherever feasible when planting is done after harvest of rice. It is necessary to use short to medium maturing varieties of rice for timely planting of rabi crops.
- **Foliar nutrition:** Since application of fertilizers under relay cropping is not feasible, seed pelleting and foliar application of nutrients should be practiced. Foliar application of 2% urea at flowering and pod formation significantly improves yields of chickpea under rainfed conditions by increasing leaf N content and making them photo synthetically more active. Seed pelleting with micronutrients like Zn and Mo is also recommended as a part of nutrient management strategy in rice fallows.

- **Plant protection:** Since post-emergence herbicides are not commercially available specially for crops like chickpea and lentil and inter-cultivation is difficult due to hard soil, hand pulling of weeds is the only option which should be done at an early stage. Post-emergence herbicide (Imazethapyr @ 50 g/ha) has been found quite effective against seasonal grassy weeds in crops like groundnut, urdbean and mungbean. It should be applied at 3-4 leaf stage. Similarly, quizalofop can be used to check ratooning of rice stubbles which cause substantial moisture loss. Insect-pests and diseases should be promptly controlled. Seed dressing with fungicides like carbendazim should be done.
- **Promotion of Sulphur & Zinc:** Wide spread deficiency of sulphur and zinc noticed in pulse growing regions constraints the productivity of pulses.
- **Application of Rhizobium & PSB**: About 40% pulse growing regions have low to medium population of native Rhizobium. Seed inoculation with bio-fertilizer (Rhizobium and PSB); low cost inputs; are known to increase pulse productivity by 10-12%.

Future strategies:

- Horizontal Expansion through bringing additional area under pulses and diversification of rice-wheat system in Indo-Gangetic plains (IGP) through popularization of short duration varieties of pigeon pea, kabuli chickpea, field pea and summer mung-bean.
- Bringing additional area under pulses through promoting urd-bean/mung-bean cultivation in rice fallow in peninsular India and chickpea lentil in NEPZ and Chhattisgarh.
- Promotion of pulses in intercropping viz., short duration thermo insensitive varieties of mung-bean/urd-bean with spring sugarcane; pre-rabi chickpea with mustard/linseed, pigeon pea with groundnut/soybean/millets.
- Development and popularization of urd-bean/mung-bean for late planting (mid Aug-early Sept in north India).

Vertical Expansion through increasing productivity and bridging the yield gaps through

Development of high yielding short duration varieties having multiple and multiracial resistance to disease and pests, development of input use efficient genotypes. Development of resilient pulse crops to climate adversaries.

Efficient water management: in rain fed areas through rainwater harvesting and recycling through farm ponds and community reservoirs; promoting short duration varieties in drought prone areas; promoting micro irrigation system; adoption of moisture conservation practices.

Development of location specific suitable varieties and ensure availability of quality seeds: production and supply of quality seeds through seed hub and ensuring seed production accountability to SAUs/ ICAR to organize location specific recommended latest varieties of pulses in their jurisdiction; active involvement of private sector, NGOs, & farmers' help groups in production of quality seeds;

Reducing post harvest losses: Refinement and popularization of harvesters, threshers and graders, development of stored grain pest resistant varieties, popularization of storage bins and mini dal mills, development and popularization of low cost safe storage structures.

Ensuring attractive price to producers: Announcement of MSP well in advance; assured procurement and creation of procurement centres in production zones; development of organized markets for pulses, linking farmers with FPOs, aggregations and E-NAM (markets); promotion of export of pulses like lentil and kabuli chickpea and arid legumes, production of value added products and use of by-products, branding of produce and promotion of organic pulse production.

Ensuring timely availability of critical inputs and advisory: Promotion of IPM technologies against pests, creation and maintain/ sustain of production units of quality bio-fertilizers and bio-pesticides, fortification of fertilizers with specific nutrients like S, Fe, Zn, B etc., in specific regions, establishment of single window input supply centers for cluster of villages, advanced forewarning and forecasting systems for pest and disease outbreaks.

Efficient transfer of technology: Organizing farmers training and exposure visits; popularization of improved technology through mass media, close interaction of research organizations, state departments of agriculture and private agencies.

CONCLUSION

Over the last four years, the on-going National Food Security Mission (NFSM) has been converged with multi– pronged strategies to enhance the production and productivity of pulses in the country. Across the country pulses constituent of the daily dining plate of a majority of the people. By adopting scientific management practices the production and productivity of pulses can be increased. Thanks to Government’s comprehensive policy, there has been a leap frog in production since 2016-17, where in ‘Five Year Roadmap’ was adopted.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 **Volume 2 – Issue 2 – February 2020**

URBAN AND PERI-URBAN AGRICULTURE: NEED OF THE HOUR

Article id: 22958

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INTRODUCTION

Indian agriculture has made rapid progress in the last few decades after green revolution to achieve self sufficiency in food, attaining record productions of food grains, milk, fruits and vegetables during the past decade. Yet, the incidences of hunger and poverty in the country have remained high despite all the efforts of Government. About one-fifth of our population, about 230 million, is hungry and undernourished, accounting for about one-fourth of the world's food insecure people. The situation is further aggravated with the fast changing climate, the shrinking land and water resources, and the rising food prices particularly in the cities.

By 2050, India with about 1.7 billion people will be the most populous country in the world, accounting for more than 17 percent of the global population but only 2 percent of land and less than 4 percent of water. And about 60 percent of the population, nearly 1 billion, will be urbanized and a good part of it will be rural migrants. The rapid urbanization will further accelerate the demand for higher quantity of quality food, especially of high value foods such as fruits, vegetables, milk, meat and eggs, from the shrinking land, water, biodiversity resources. Moreover, the crowding cities and their peripheries will be facing increased pollution and warming. In face of the above challenges, urban and peri-urban agriculture (UPA) which refers to food production systems and value chains within cities and their surroundings must become an integral part of the national agricultural production and distribution systems.

Urban and peri-urban agriculture (UPA) occurs within and surrounding the boundaries of cities throughout the world and includes products from crop and livestock agriculture, fisheries and forestry in the urban and peri-urban area. It also includes non-wood forest products, as well as ecological services provided by agriculture, fisheries and forestry. Often multiple farming and gardening systems exist in and near a single city (FAO, 1999). Because of the multifaceted nature of the urban food insecurity there is need of an interdisciplinary, integrated approach to the urban sector. We need to distinguish between the production of perishable, nutrient-rich and essentially commercial foods, such as vegetables, fruits, eggs, milk and poultry, on the one hand, and of staple foods and other subsistence foods, on the other.

Urban agriculture is generally practiced on small to medium size holdings within cities for growing annual and tree crops, raising small livestock and fish for home consumption or sale. The peri-urban agriculture is aimed to meet part of food demand of urban population by efficient utilization of land. Globally, urban and peri-urban agriculture is gaining attention from governments, and many international organizations like the United Nations Conference on Environment and Development (UNCED), United Nations Center for Human Settlements (UNCHS), the FAO and the Consultative Group on International Agricultural Research (CGIAR).

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Peri-urban agriculture happens on farm units close to town that operate intensive semi- or fully commercial farms to grow vegetables and other horticulture, raise chickens and other livestock, and produce milk and eggs. Peri-urban agriculture embraces other activities too, such as fish farming. Peri-urban agriculture has been supported for a long time through development projects and technical assistance (e.g. in the 1970s and 1980s through OECD). The peri-urban areas of most cities are explicit sites for horticulture. The recent interest in UPA is a consequence of rapidly growing cities in the South and the related food insecurity in these cities.

UPA comprises a set of different possible activities. The scope of urban and peri-urban food production varies from continent to continent. This variation derives from many factors, e.g., the economic status of the country and the households (which determine their needs), the household itself (determined by its size, labour force, assets etc.), Cultural aspects (which partly determine the kind of crops grown), the infrastructure and availability of fossil energy and inputs (which determine transportation capacities, availability of seeds and fertilizers), climate, soils and water. The main components of UPA are:

- Urban and peri-urban horticulture and crop production
- Urban and peri-urban animal husbandry
- Urban and peri-urban forestry
- Urban and peri-urban aquaculture

Urban agriculture can be practiced:

- on vacant plots
- in home gardens
- in containers
- on balconies
- on roof tops
- in fishponds
- in school gardens
- on open spaces
- on road strips
- along Railways
- below power lines
- on river banks
- in rivers
- on communal lands for community based gardening

Aims of Urban and peri-urban agriculture

- Aim food production
- Income generation and recreational opportunities
- Contribute to the prevention of micronutrient deficiencies ‰
- Can enrich the urban environment
- Improve access to consumer markets imply less need for packaging, storage and transportation of food
- Create potential agricultural jobs and incomes‰
- Provide non-market access to food for poor consumers‰
- Increase availability of fresh, perishable food ‰
- Improve proximity to services, including waste treatment facilities
- Create opportunities for waste recycling and re-use possibilities ‰
- Contribute to preserve and improve biological diversity by integrating it in the ecosystem

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Urban and peri-urban horticulture

In cities, environmental benefits and synergies can be achieved when horticulture is planned as a part of the urban landscape including safe recycling of solid waste and waste water. Further, trees and other ornamental plants are crucial for sequestration of carbon from atmosphere and play an important role in reducing carbon footprint. Moreover, flowering /foliage plants in the garden not only add beauty but also help to improve the ecosystem. Among the various gardening options, terrace gardening, a raised ground space around a dwelling house or on the sides of a hill, forms a link between the house and the rest of the outdoor living space and must, therefore, be designed in harmony with the plan of the house. Roof garden is one of popular alternatives in urban and peri-urban areas, because of the lack of available space on the grounds of a house. Particularly, in the big cities and towns, the only space left for garden enthusiasts is the roof of the house and the balcony. To ensure the success of roof gardening, technical and developmental support is inevitable. Green cities have become an option to mitigate the impact and adapt to climate change.

Urban and peri-urban aquaculture: The significance of aqua farming in and around Kolkata and other metro cities suggests potential of fisheries in waste water. Aquaculture in waste water is regarded as an answer for reversing declining supplies from capture fisheries, and the activity has notable potential for new livelihood opportunities, providing a mechanism for availability of low priced fishes, enhanced nutritional security and employment for poor communities by servicing urban markets.

Livestock in urban and peri-urban areas: Peri-urban and urban dairy production system is becoming an important supplier of milk products to urban centers, where the demand for milk and milk products is remarkably high. As a result of this, peri-urban and urban dairying is being intensified through the use of cross bred dairy cows, purchased and conserved feed and stall-feeding. The system is favored due to the proximity of the production sites to centers of high fresh milk demand, easy access to agro-industrial by- products, veterinary services and supplies. Commercial poultry production is mostly located in outskirts of the urban areas. The impressive growth in the poultry meat industry is the result of technological breakthroughs in breeding, feeding and health, and sizeable investments from the private sector. Private sector partnership in broiler production through contract farming systems and the vertical integration has played a major role in this spectacular growth, especially in Tamil Nadu, Andhra Pradesh, West Bengal, Maharastra, Karnataka and Punjab which are the major broiler producing states of the country.

Emerging issues in UPA

- The low availability and high cost of land in urban / peri urban areas may not encourage UPA.
- While horticultural crops appear environmentally compatible in densely populated urban set up, livestock farming has the constraint of transmission of many diseases.

- Likewise aquaculture may have potential but certain water born diseases will be of concern. Recent phenomenon of cross-species transmission of virus from animals to human is becoming a challenging problem as seen in the origin of HIV, mad cow disease, SARS virus, bird flu and swine flu.
- Many of these seem to have originated in countries where heavy density population of the live stocks exist very near or in thickly populated areas. Small fishpond impoundments increase the overall aggregate shoreline of ponds causing spread of malaria.
- Use of untreated animal or human wastes in aquaculture ponds to increase fish production also puts both human and animal at risk.
- The use of waste water for irrigation without careful treatment and monitoring can result in the spread of diseases. Besides, cultivation on contaminated land also represents a health hazard for the consumers.
- Pesticide residue in the urban and peri-urban horticulture may become high, besides polluted water with heavy metals and cleaning vegetables in water contaminated with bacteria and viruses after harvesting is also an issue.
- Solid waste management projects in past have failed because cost of management for preparation of compost is very high, and would need a re-look.

Therefore, public health safety is essential to ensure that any of the activities of UPA does not cause unacceptable risks to public health and negate its potential economic and nutritional benefits.

CONCLUSION

UPA should be a significant approach towards a vibrant food environment and resilient food system. An eco-friendly and efficient UPA will not only be overwhelming, contributing to the efforts of adequately feeding the cities, but will also create employment and generate income particularly for the poor, besides greening the cities, the environment and the human health. Utilization of available water and pre-treatment measures for waste water utilization for growing plants in the cities is an important aspect. In particular, technologies for protected cultivation suiting to urban and peri-urban agriculture are needed.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Agronomic management practices for soil health and carbon sequestration

Article id: 22959

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INTRODUCTION

Carbon is found in all living organisms and is the major building block for life on Earth. Carbon exists in many forms, predominately as plant biomass, soil organic matter, and as the gas carbon dioxide (CO2) in the atmosphere, and dissolved in seawater. Carbon dioxide is the prime greenhouse gas responsible for global warming. Soil is a large reservoir of carbon, with about 60% organic carbon in the form of soil organic matter (SOM), and the remaining inorganic carbon in the form of inorganic compounds (e.g., limestone, or CaCO3). It is estimated that SOM stores about twice as much carbon as the atmosphere, and about three times as much as forests and other vegetation.

Soil carbon sequestration is the removal of CO_2 from the atmosphere through plant photosynthesis, and storage as long-lived, stable forms of soil organic matter that is not rapidly decomposed (Lal, 2008).

Ways that carbon can be stored (sequestered):

- Deep in ocean “ocean sequestration”
- Underground “geological sequestration”
- In plants and soil “terrestrial sequestration”
- As a solid material (still in development)

Ocean sequestration

Industrially generated CO_2 is pumped into deep underground formations and dissolves in the native formation fluids. Some of the dissolved CO_2 would chemically react and become part of solid mineral/ coal matrix. Once dissolved or reacted to form minerals, CO_2 is no longer buoyant and would not rise to the ground surface. Two main concepts exist. The 'dissolution' type injects CO2 by ship or pipeline into the water column at depths of 1000 m or more, and the CO2 subsequently dissolves. The 'lake' type deposits CO2 directly onto the sea floor at depths greater than 3000 m, where CO2 is denser than water and is expected to form a 'lake' that would delay dissolution of CO2 into the environment. In the case of deep ocean storage, there is a risk of greatly increasing the problem of ocean acidification, a problem that also stems from the excess of carbon dioxide already in the atmosphere and oceans.

Geological storage

Also known as *geo-sequestration*, this method involves injecting carbon dioxide directly into underground geological formations. Oil fields, gas fields, saline formations, unminable coal seams, and saline-filled basalt formations have been suggested as storage sites. Here, various physical (e.g., highly impermeable caprock) and geochemical trapping mechanisms would prevent the CO_2 from escaping to the surface. CO_2 is sometimes injected into declining oil fields to increase oil recovery (enhanced oil recovery). This option is attractive because the storage costs are offset by the sale of additional oil that is recovered. Disadvantages of old oil fields are their geographic distribution and their limited capacity.

Terrestrial C-Sequestration

Terrestrial carbon sequestration is defined as either the net removal of CO_2 from the atmosphere or the prevention of CO_2 net emissions from the terrestrial ecosystems into the atmosphere. It is the enhancement of CO_2 uptake by plants that grow on land and in freshwater and, importantly, the enhancement of carbon storage in soils where it may remain more permanently stored. Terrestrial sequestration provides an opportunity for low-cost CO_2 emissions offsets. Early efforts include tree-plantings, no-till farming, and forest preservation. Storage of C in soils and plants has the potential to offset CO_2 emissions to the atmosphere in the coming decades while new 'clean' energy production and CO_2 sequestration technologies are developed and deployed. Carbon seq. rates differ based on the species of tree, type of soil, regional climate, topography & management practice. Carbon accumulation eventually reaches saturation point where additional sequestration is no longer possible (when trees reach maturity, or when the organic matter in soils builds back up to original levels before losses occurred). After saturation, the trees or agricultural practices still need to be sustained to maintain the accumulated carbon and prevent subsequent losses of carbon back to the atmosphere. At the global level, the IPCC Third Assessment Report estimates that ~100 billion metric tons of carbon over the next 50 years could be sequestered through forest preservation, tree planting and improved agricultural management.

The following ecosystems offer significant opportunity for carbon sequestration:

- Forest lands
- Agricultural lands
- Biomass croplands
- Deserts and degraded lands
- Wetlands and peat lands

- Improved Cropping Systems
- Conservation Tillage
- Cropland to Grassland
- Drainage, Wetland Management

Changes in soil organic carbon levels can have significant effects on atmospheric CO2 levels. How is carbon sequestered in soils? Through the process of photosynthesis, plants assimilate carbon and return some of it to the atmosphere through respiration. The carbon that remains as plant tissue is then consumed by animals or added to the soil as litter when plants die and decompose. The primary way that carbon is stored in the soil is as soil organic matter (SOM). SOM is a complex mixture of carbon compounds, consisting of decomposing plant and animal tissue, microbes (protozoa, nematodes, fungi, and bacteria), and carbon associated with soil minerals. Carbon can remain stored in soils for millennia, or be quickly released back into the atmosphere. Climatic conditions, natural vegetation, soil texture, and drainage all affect the amount and length of time carbon is stored. In agricultural systems, the amount and length of time carbon is stored is determined predominately by how the soil is managed. A variety of agricultural practices can enhance carbon sequestration in soils. The benefits of these practices as well as their potential hidden costs must be considered when management decisions are made. Though not discussed here, there may also be direct or indirect monetary costs and benefits to farmers to implement these techniques.

Benefits of carbon sequestration

In addition to reducing current atmospheric CO2 levels, increasing soil carbon sequestration can provide other benefits for soil health, the environment, and crop production:

- Improved soil structure
- Increased soil fertility
- Increased water holding capacity
- Increased water use efficiency
- Increased infiltration capacity
- Improved soil health resulting in higher nutrient cycling and availability
- Reduced fertilizer (N, P) needs over the longer term
- Increased agricultural productivity and profitability

Management practices for soil carbon sequestration

A wide range of the good agricultural practices exist for sequestering organic carbon in agricultural soils. Appropriate practices differ for different soil, crop, and climate conditions. A site-specific approach should be used to select the most appropriate practice to meet local needs by considering all inputs and benefits/costs associated with each input. A life-cycle analysis that considers inputs and associated environmental and economic benefits needs to be carried out. For example, no-till or minimum-till has been identified as one of the best practices to sequester soil organic carbon. However, it may require use of herbicides, which have both environmental and economic implications.

Agronomic practices for soil carbon sequestration-

The following management practices can increase soil carbon sequestration and help mitigate climate change.

Addition of organic soil amendments such as compost, animal manure and biosolids: Manure inputs increase soil organic carbon. Continued input is required in order to maintain higher soil organic carbon level. Once the addition stops, much of the carbon “sequestered “in the soil may be lost due to decomposition. Some residual benefits from manure addition, however, may last for long periods, as improved soil conditions increase productivity and plant residue input into the soil. The quality of organic carbon inputs is important for soil carbon sequestration. The conversion efficiencies of manure are almost twice that of plant residues. In other words, for constant rates of addition, net soil organic carbon accumulation from manure is nearly twice of that from plant residue additions. It is postulated that the slower decomposition of manure in soils results from the fact that manure consists of largely partially decomposed products. Similarly, products of aerobic composting and anaerobic digestion are also expected to have higher efficiencies for increasing soil organic carbon content than plant materials. There is an important implication from these results. Soil organic carbon levels have generally decreased upon cultivation. This is partly because of the increased decomposition of soil organic carbon resulting from tillage and partly because of the decreased inputs as a result of the removal of above ground plant biomass.

Reduced tillage/Zero tillage: Increased soil organic carbon decomposition from tillage is one of the major factors responsible for the decrease in soil organic carbon content upon cultivation. As a result, avoiding tillage has generally been reported to increase soil organic carbon content. Reducing tillage intensity minimizes or eliminates manipulation of the soil and leaves crop residues on the soil surface. These procedures generally reduce soil erosion, improve water use efficiency, and increase carbon concentrations in the topsoil. Reduced tillage can also reduce the amount of fossil fuel consumed by farm operations. It has been estimated to have the potential to sequester a significant amount of CO2.

Cover cropping: Cover cropping is the growing of soil covering crops such as mucuna, horse gram for protection and soil improvement between periods of regular crop production. Cover crops improve carbon sequestration by enhancing soil structure, and adding organic matter to the soil.

Crop rotation: Crop rotation refers to growing a sequence of crops in regularly recurring succession on the same area of land. It mimics the diversity of natural ecosystems more closely than intensive monocropping practices. Varying the type of crops grown can increase the level of soil organic matter. However, effectiveness of crop rotations depends on the type of crops and crop rotation times.

Enhancing biological N fixation through the use of legume crops: Increasing crop yields increases plant residue input into the soils and thus has the potential of increasing soil organic carbon level. Further, for each legume crop grown, there is approximately 1 ton of CO2-C emission that is avoided in terms of savings on N fertilizer whose manufacture involves fossil fuel burning. The carbon emission savings from using legume plants is permanent while soil carbon content increase resulting from increased inputs must be maintained continuously.

Including crops/varieties with higher root biomass in the cropping system: There is reason to believe that most of the carbon sequestered in soil originates from roots (Rasse *et al.*, 2005). By virtue of its inherently low decomposability, and their much more intimate interaction with soil particles and aggregates, root carbon has greater opportunity for being sequestered in soil in stable form that carbon applied through plant residues or manures (Srinivas, 2017). Inclusion of crops/varieties with greater root biomass and management practices that encourage better root growth, especially in deeper soil layers can lead to considerable carbon sequestration in soil.

Avoiding fallow: Fallowing significantly increases the rate of soil organic carbon decomposition. Research results indicate that during fallow the rate of soil organic carbon decomposition is approximately 2 to 2.5 times faster than in a crop year. Thus, to maintain soil organic carbon level, if the fallow frequency is once every two years, the organic carbon input must be 1.5 times higher than in a system with no fallow. As a result, the fallow treatment often results in significantly more soil organic carbon loss than continuously cropped treatment.

Application of recommended doses of nutrients: The application of adequate nutrients through integrated nutrient management ensures greater crop production, greater root growth and greater availability of biomass for recycling. Long term experiments consistently show improvement in soil organic matter with application of recommended doses of nutrients through integrated nutrient management.

Biochar: Biochar is a microbial resistant carbon substance which is produced by heating organic wastes such as crop residues or wood chips in the absence of oxygen by a process called pyrolysis. Ordinary biomass fuels are carbon neutral; the carbon captured in the biomass by photosynthesis is eventually returned to the atmosphere through natural processes like decomposition. Sustainable biochar systems can be carbon negative by transforming the carbon in biomass into stable carbon structures in biochar which can remain sequestered in soils for hundreds and even thousands of years.

CONCLUSION

As the concentration of CO_2 is increasing day by day in the atmosphere threatening the living organisms and global agriculture carbon sequestration has become more important in recent times. Terrestrial sequestration provides an opportunity for low-cost CO_2 emission offsets. Good agricultural practices can be the sustainable alternative for soil carbon sequestration in addition to carbon capture and storage by industrial means. Besides the agronomic practices, agro-forestry/farm-forestry is the way out for C-sequestration in rain fed areas. Increasing forest carbon sequestration has other positive benefits. Government support, policy initiatives, research, new infrastructure and land owner assistance would be required to increase the rate of carbon sequestration to mitigate climate change and sustain soil health.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

INSECTS ACT AS ZOMBIES

Article id: 22960

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INTRODUCTION

ZOMBIE: The term "Zombie" comes from Haitian folklore, in which means "dead body reanimated through various methods" commonly magic. Zombies are most commonly found in horror and fantasy genre works. Modern depictions of the reanimation of the dead do not necessarily involve magic but often includes science fictional methods such as carriers, radiation, mental diseases, vectors, pathogens, parasites, scientific accidents, etc

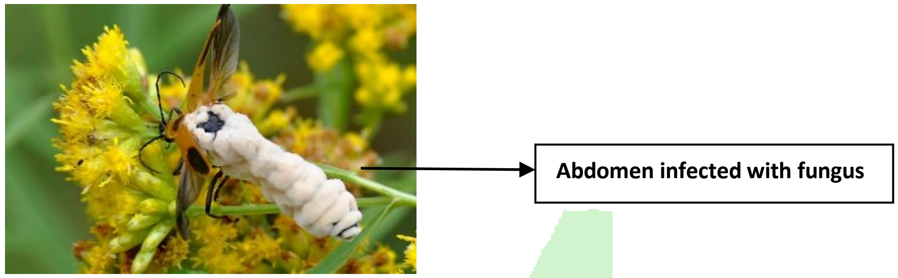
INSECT ZOMBIES: Some of the parasites like insects, fungus and virus that can turn insects into zombies. They control the mind of insects to guard the parasites offspring or even made to commit suicide.

S.No	Name of the insect	Parasite	Work of zombie
1.	Goldenrod soldier beetle	*Eryniopsis lampyridarum* (Fungus)	Spore dispensers
2.	Lady bird beetle	*Dinocampus coccinellae*	Sex slave
3.	Ant	*Ophiocordyceps* (Fungus)	Spore dispensers

1. Fungus turns beetle into zombie:

Goldenrod soldier beetle or Pennsylvania leather wing- *Chauliognathus pensylvanicus* native to North America, and is one of the most common species of soldier beetle in the Midwest. Adult *C. pensylvanicus* that look like wasps or bees, but they were harmless beetles and key pollinators that have a life span of one year. They live in meadows and fields and survive by eating flowers. Their larvae are voracious, eating other insects and possibly even ticks. It belongs to the family Cantharidae.

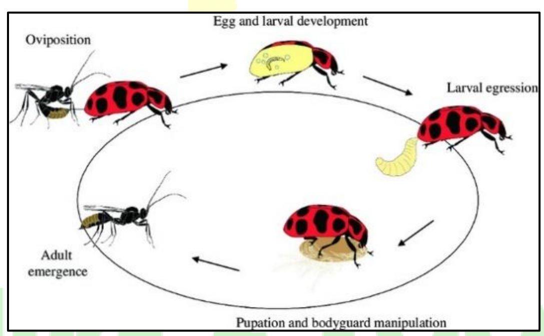
Adult beetle mate by sitting on the top of the flower which is a behaviour of them. Adult *C. pensylvanicus* were infected by the fungus *Eryniopsis lampyridarum* that was already present on the flowers on which they feed. This fungus makes the beetles into zombies. Shortly before death, by unknown mechanism dying infected beetles tightly clamp their mandibles into flower heads. 15–22 hours later, the fungus caused dead beetles to raise their elytra and expand their metathoracic wings in order to maximise infection of other beetles. With their wings raised, the dead beetles may still attract mates as live males were observed mating with the infected females (Zombies). In this process uninfected male become infected with the fungus.



2. Wasp virus turns beetle into zombie babysitters:

The Green-eyed wasp- *Dinocampus coccinellae* is a braconid wasp parasite of coccinellid beetles, including the spotted lady beetle, *Coleomegilla maculata*. *D. coccinellae* has been described as *turning* its *ladybird* host *into* a temporary "*zombie*" guarding the wasp cocoon with the help of virus.

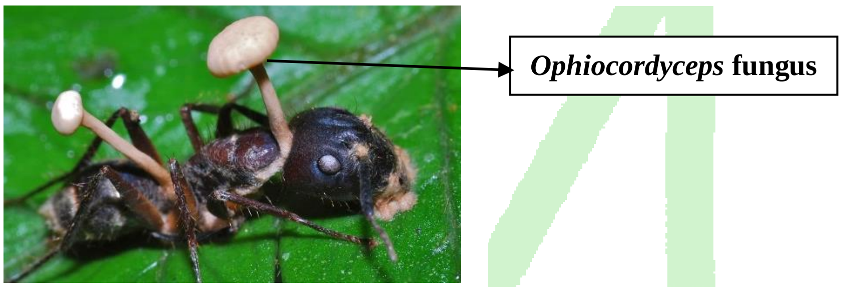
Iflavirus, a type of RNA virus related to the polio virus- *D. coccinellae* paralysis virus (DCPV). DCPV was injected into beetle's brain. *D. coccinellae* turns ladybugs into zombie babysitters or sex slaves. After three weeks a wasp lays its egg inside the hapless beetle. Wasp larva bursts from her belly and weaves itself a cocoon between her legs. The ladybug doesn't die, but becomes paralyzed, involuntarily twitching her spotted red carapace to ward off predators until the adult wasp emerges a week later. Wasp virus that attacks the beetle's brain and make them as zombies till wasp larva hatches out from the cocoon. *D. coccinellae* larva grows within her, by consuming on her internal organs. Many parasites use mind control to manipulate their hosts.



3. Fungus turns ants in into zombies:

Ants are used as spore dispensers by fungus. The *Ophiocordyceps* fungus turns tropical ants into zombie spore dispensers.

Entire body of the ant has become a puppet for the Cordyceps fungi – it's a dead ant walking but its brain was still functioning. When the fungus first enters its host, it exists as single cells that float around the ant's bloodstream, rapidly producing new copies of itself which then begin to join up and work together, physically connecting with tube like structures which allow it to share nutrients. In a sense the microscopic cells join forces, ironically much like a colony of ants, to create a super organism and take over the host's body. This fungus forces the insect to leave the safety of the nest and climb the nearest plant, and lock itself into place on the stem. The fungus then sends a long stalk through the ant's head which grows into a capsule full of spores, which can then rain down on the nest below it, infecting other ant in turn. This parasite avoids killing the host, until its work was done.



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Plant defense mechanisms against biotrophic fungi infection

Article id: 22961

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INTRODUCTION:

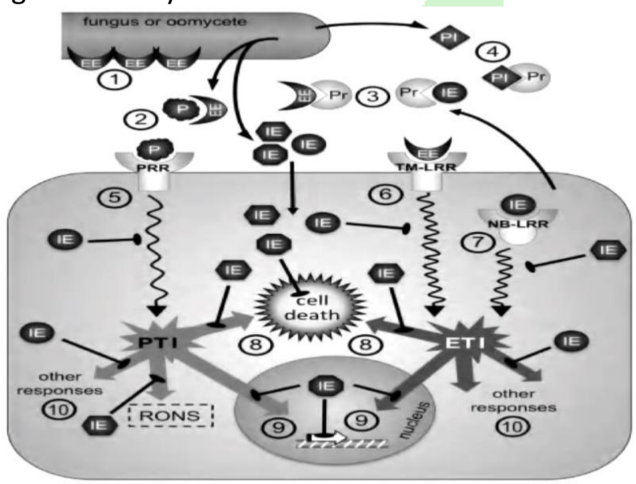
Plant pathogens are classified in three major groups based on their nutrition methods: Biotrophs, Necrotrophs and Hemibiotrophs. Biotrophic pathogens derive nutrients from living cells by maintaining the host viability. Biotrophic fungi and their plant hosts have highly specialized relationship structurally and also biochemically. Biotrophic fungi penetrate the host cell wall and colonize the intercellular space using feeding structures like haustoria to absorb nutrients and suppress host defenses without disrupting the plasma membrane. A constant balance between virulence and evading host detection show a sophisticated form of pathogenesis of biotrophic fungi. By the feeding activities, biotrophic fungi create a nutrient sink to the infection site, so that the host gets disadvantage and shows serious yield loss. This type of parasitism is very sophisticated which keeps the host alive as a long term source of food. Among various plant pathogenic fungi, powdery mildew fungi (Ascomycota) and rust fungi (Basidiomycota) are coming under biotrophic fungi group.

Mechanisms of Biotrophic fungi infection in plant:

Plant pathogens have to pass the complex multilayered defense system in plant for compatible interaction. Fungus protection may include fungal chitin shield, scavenger, which protect the cell wall and the chitin fragments of fungus from chitinases. For the success of pathogenesis including attachment, host recognition, penetration and proliferation biotrophic fungi form infection structure. For valuable virulence activity the biotrophic fungi have highly developed infection structures; limited secretory activity, especially of lytic enzymes; carbohydrate rich and protein containing interfacial layers, which separate fungal and plant plasma membranes; long term suppression of host defense; haustoria that used for nutrient absorption and metabolism. Biotrophic fungi also have several mechanisms to defend their effectors from host receptor molecules. Once the fungal effector passes host defense mechanism, the plant will not resist. Subsequently, the plant reduces production of defense signaling molecules like salicylic acid (SA).

Plant defense mechanisms against Biotrophic fungi infection:

There are two main strategies that plants use to restrict the invasion and growth of biotrophic fungi: penetration resistance and programmed cell death (PCD) mediated resistance. Plant strengthens cell wall and membrane to halt spore germination and prevents the formation of haustorium by penetration resistance. The second resistance mechanism is applied inside the penetrated epidermal cell that terminates nutrient supply to fungi for further development by induction of invaded programmed cell death. Plant innate immune responses occur through two basic inter-connected forms: pathogen associated molecular patterns (PAMP) triggered immunity (PTI) and effector triggered immunity (ETI). By the interaction of pathogen effector proteins and extracellular pattern recognition receptors in the plasma membrane of the host cell PTI is activated. PTI is mediated by membrane embedded receptor-like proteins (RLPs), receptor-like kinases (RLKs) and receptor-like cytoplasmic kinases (RLCKs). Certain isolates have become 'adapted' to a specific host through revolution. Plant acquires resistance (R) proteins that specifically recognize pathogen effectors to activate ETI. ETI is commonly associated with PCD that prevents biotrophic pathogens from acquiring nutrients and completing their life cycle.



EE=Extracellular effectors outside apoplast. IE= intracellular effectors. (1) Prevent effector from cell walls or (2) prevent recognition receptors (PRR). Plants secrete proteases (Pr) (3) to degrade IE or EE, but pathogens (4) secrete protease inhibitors (PI) to block those proteases. Recognition of PAMPs by PRRs (5) produces signaling events that trigger PAMP-triggered immune responses (PTI). Recognition of EE by trans-membrane leucine-rich receptors (TM-LRRs) (6) or recognition of IE by nucleotide-binding leucine-rich receptors (NB-LRRs) (7) leads to effector-triggered immune responses (ETI). Signaling events for both PTI and ETI may be inhibited by intracellular effectors. PTI and ETI both produce programmed cell death (8), and effectors may inhibit the triggering of cell death or the cell death machinery itself. PTI and ETI both involve transcriptional changes (9), and nuclear-targeted effectors may interfere with signaling within the nucleus or transcriptional events directly. PTI and ETI involve numerous other responses (10), including the production of reactive oxygen and nitrogen species (RONS), and effectors may interfere with those responses as well.

Fig 1: Defense effector entering the host cell through several pathways

PAMP-Triggered Immunity (PTI) against Bitrophic fungi:

Penetration resistance is the major component of PTI against the non-adapted biotrophic fungi. PTI responses are selected for its immune enhancement without much fitness cost. Due to the low specificity in pathogen recognition, PTI may not be beneficiary for plants in the infection of adapted biotrophic fungal pathogens.

Effector-Triggered Immunity (ETI) against Biotrophic fungi:

R-genes in plants encode proteins with nucleotide binding (NB) site – leucine-rich repeat (LRR) domains. These NB-LRR proteins particularly detect the microbial effector molecules and initiate ETI, which is highly effective against biotrophic fungal pathogens. Effectors, in opposite to MAMPs, are properties of strong pathogens. Therefore plant activates strong immune responses in ETI directly after recognition of very low concentration pathogen elicitors by an R protein in order to secrete strong signals. Consequently, destruction of some signaling sectors by pathogen effectors do not have a large impact on overall immunity in plant.

Activation of signal molecules in plant:

The contact of fungi elicitors with host R-gene product activates primary and secondary signal molecules. Primary or Early signaling events, those are observed during disease defense, include reactive oxygen species (ROS), protein phosphorylation and ion fluxes. The regulation of these primary events is assisted by different gene expressional changes. Different fungal elicitors have been studied to activate fluxes of Cl^-, K^+, H^+, and Ca^{2+} across the plasma membrane. Accumulation of oxidative burst or reactive oxygen species (ROS) that include 0_2^- and H_20_2 is another remarkable event occurs as early signaling molecule during pathogen infection. Accumulation of ROS by pathogen effectors may be linked with the activation of ionic influx and protein phosphorylation.

After the early signal molecules are triggered by pathogen infection, the elicitor signals are frequently multiplied via the secretion of secondary signal molecules like ethylene, salicylic acid (SA) and jasmonates. These three phytohormones are known to play vital roles in regulating plant defense responses against various pathogens. SA levels increase in pathogen exposed plant tissues and exogenous SA addition results the induction of pathogenesis related (PR) genes and improved resistance to a wide range of pathogens. But ethylene and jasmonates dependent defenses are not so important in plant-biotrophic fungi interaction.

CONCLUSION:

Plant innate immune responses *i.e.*, PAMP-Triggered Immunity (PTI) and Effector Triggered Immunity (ETI) occur to activate defense signal molecules because of the recognition of effectors by pattern-recognition receptors and R proteins respectively. However, biotrophic fungi have several mechanisms to defend their effectors from plant receptor molecules and also rapid evolving system of their putative effectors. Once the fungal effector passes plant defense mechanism, the plant will not resist. Subsequently, the plant reduces production of defense signaling molecules like salicylic acid.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 **Volume 2 – Issue 2 – February 2020**

Refractance Window Drying of Foods

Article id: 22962

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Drying is heat and mass transfer operation in which water is removed from products by application of heat. The final obtained product may be in the form of sheets, film, powder, flakes, and granules. In the food industry dehydration process yet have been used decades to provide microbial stability, facilitate storage, reduce deteriorative chemical reactions and minimize transportation costs. Even though these objectives of drying as a unit operation are still relevant and important, today's consumers prefer more nutritious products with most of the health-promoting bioactive compounds retained. In response to consumers demand, recent development activities, product quality is a major parameter in the design of food dryers which indicates the dryer performance. Freeze drying has been used in order to produce dehydrated products with good retention of shape, colour, vitamins, flavor, and rehydration ability. However, the cost of freeze drying is several times higher than spray drying and air-drying. Moreover, freeze-dried products tend to be porous and may rehydrate rapidly when exposed to a humid environment. The new emerging drying techniques are Refractance window drying that provide certain significant advantages in terms of one or more of the following. Apart from this energy source, the level of temperature (high or low), residence times of product in dryer, and whether the heating medium contact with material directly or indirectly are the other considerations in design for quality. It is also important to consider whether the heat is to be transferred to the wet material by convection, conduction, radiation, or a combination of those processes. In most drying operations, energy is transferred from the surface to the centre of the wet material with the exception of radiofrequency and microwave drying, where the energy supplied generates internal heat within the solid.

The drying methods involved in food industry in order to produce food powders, leathers, or sheets from juices, flakes, purees, pastes, or suspensions are drum, spray, and conveyor drying. Drying technologies belong to first, second, third or fourth generation. Cabinet and bed type dryers such as kiln, tray, truck tray, rotary flow conveyor and tunnel using hot air as the medium of heat transfer belong to first generation and better suit solid materials including food grains and horticultural commodities. Spray and drum dryers are second generation technologies and better suit slurries and pastes that require to be dried in the form of flakes and powders. Freeze dehydration and osmotic dehydration belong to third generation of drying technologies. Microwave drying, infrared drying, heat pump drying, fluidized bed drying, radio frequency drying and Refractance window (RW™) drying are considered as fourth generation drying technologies based on the type of raw materials they can handle and the retention of quality attributes of the intended products. The comparison table of difference drying technologies on the basis of energy consumption, capacity and thermal efficiency are given below.

Table 1: Comparison of energy consumption of RW™ with selected other drying techniques

Dryer Type	Typical capacity, kg H_2O/h per m^3 or m^2	Typical energy consumption, kJ/kg of H_2O	Thermal efficiency (%)
Impingement dryer	50	5000-7000	32.9-46
Rotary dryer	30-80	4600-9200	25-50
Fluid bed dryer	-	4000-6000	38-58
Flash dryer	5-100	4500-9000	26-51
Spray dryer	1-30	4500-11500	20-51
Drum dryer	6-30	3200-6500	35-78
Tunnel dryer	-	5500-6000	38-42
Band dryer	-	4000-6000	38-58
Refractance window drying	**6**	**4743**	**28-46**

Each of those methods has certain advantages as well as limitations that dictate their choice for handling a particular product and are briefly reviewed in this article for comparison with RW drying method. Among these methods, RW™ drying is a recent non-thermal method for drying products including heat sensitive purees and slices of fruits and vegetables. The RW is a emerging drying techniques that provide certain significant advantages in terms of the level of temperature (high or low), residence times of product in dryer, and whether the heating medium contact with material directly or indirectly. It is also important to consider whether the heat is to be transferred to the wet material by convection, conduction, radiation, or a combination of those processes. In most drying operations, energy is transferred from the surface to the centre of the wet material with the exception of radiofrequency and microwave drying, where the energy supplied generates internal heat within the solid. The RW drying system utilizes circulating hot water, maintained in the temperature range of 95–97˚C at atmospheric pressure and carry thermal energy by which material to be dehydrated. Thermal energy from circulating hot water is transferred to the wet product via a plastic interface that is relatively transparent to infrared radiation. The actual product temperature is usually below 70˚C. Products like as juice, purees, and suspensions, are dried by RW method of drying.

The major components of a typical RW™ drying system are thin infrared transparent material (such as pyrex glass) or polyethylene film (such as Mylar® film), belt conveyor, hot water, pomp, heat exchanger and scraper. Food materials applied over a thin infrared transparent material (such as pyrex glass) or polyethylene film (such as Mylar® film) resting over the surface of water get heated. The film material can either be moving or stationary. In a moving film configuration, the food is usually moved concurrently with the hot water, with belt velocities between 0.6 and 3 m/min. Thermal energy carried by the circulating water (maintained between 94 and 98 ˚C) transmits sensible heat through the film to the food material spread as a thin layer over the film by conduction and radiation. This approach is characteristic to the RW™ technique.

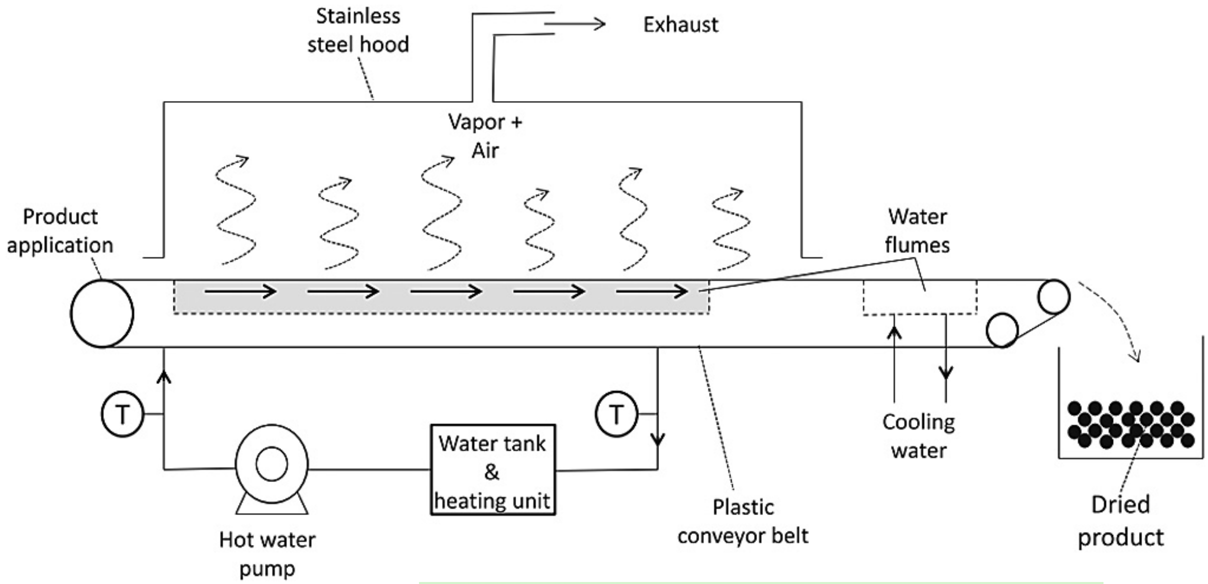

Fig. Schematic Diagram of a RW™ Drying System

Water in the food is quickly evaporated owing to rapid transfer of heat energy, resulting in a state of thermal equilibrium. Additionally, radiation effects are also evident; depending on the material properties.

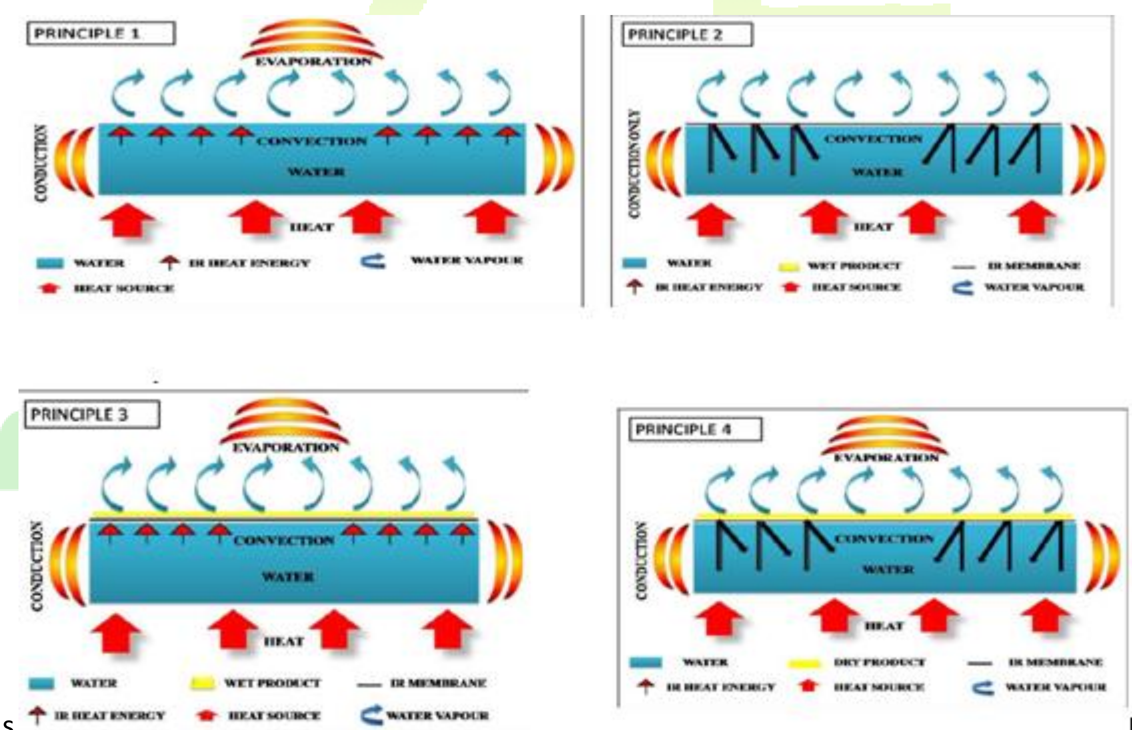

Fig: Principle of Refractance window drying

This mechanism ideally involves a 'window' through which heat and mass transfer occurs. This window allows the passage of infrared energy through the moist material placed on the plastic membrane's surface. Almost half of the total thermal radiation interact the food material which spread over the film. Heat gets transferred to the water molecules directly and product temperatures can reach up to 74 ˚C and are highly dependent on moisture content, bed thickness and product consistency. As the moisture evaporated from the product, the drying 'window closes' and 'refracts' back into the heated water source, particularly thermal radiation getting reflected back into with increase in refractive index. Analyzed heat transfer fluxes during the RW™ drying process and concluded that infrared emissions of the hot water account only to around 3% of the total heat supplied to the product during the constant rate drying period. Conduction effects continue to support moisture evaporation until the product reaches critical moisture content. Associated evaporative cooling effects (justifying why product temperature is always lesser than the temperature of water at any point of drying) occur during latter stages of drying. With reduction in the rate of heat transfer, the product is protected from overheating. At the end of drying process, the product is cooled down by moving over cold water and separated from the belt by a scraper device. This is essentially done to bring down the product's temperature below the glass transition temperature and avoid product stickiness. The circulating water is often reused after reheating to improve the thermal efficiency of the system. The entire process occurs under atmospheric conditions. Accordingly, RW™ drying is a contact, indirect, film-drying technique which also avoids product cross-contamination during drying. Among various sensory attributes, colour is a critical decider of product quality and RW™ drying in most cases results in lower DE values as compared with other drying techniques RW™ systems can: (1) even be operated with product temperatures not exceeding 30˚C, making it suitable to dry microbial cultures (and other bioactive constituents) with acceptable viability and that (2) they have the capability to reduce inoculums populations of coliforms and E.coli by up to 106 CFU/ml. Nevertheless, their effects on polysaccharides causing irreversible structural modifications and changes in physiological and pharmacological characteristics need to be thoroughly examined; particularly for food sources rich in bioactives. for the same level of temperature in the contact medium (water in the case of RW™ drying and air in the case of convective air drying), the relative product temperature gains in RW™ is significantly lower than those in convective air drying, justifying direct implications on improved product. Product moisture and storage temperature directly affect storage stability of RW™ dried powders. Head space gas composition and packaging type are also other essential considerations during storage of RW™ dried products and RW™ drying produces powders with low water activity and good storage stability. The RW™ drying approach can be effectively used for drying highly perishable foods such as meat. Meat based protein rich powders with minimal risk to microbial contamination can be developed using RW™ drying.

Effect of RW Drying on product quality.

S N.	Food Matrix	Refractance window Drying	Major findings	References
1	Thawed frozen mango puree	Effective surface drying area of 1.10 m2; belt length of 1.83 m; temperature of hot circulating water: $95-97^{0}$ C	Showed **characteristic yellow colour** than the freeze dried powder; higher chroma and hue values.	**Caparino et al., 2012**
2	Tomato	Temperature Combination : 40 min, 90 C; 60 min, 75^{0} C and 75 min, 60^{0} C	**Solubility** of dried powder 63.16%-65.94%	**Abul-Fadl and Ghanem, 2011**
3	Mango slices of 1 and 2 mm thickness	0.26 mm thick plastic film; water at 95 ^{0}C	**25% lesser drying time** to reduce a_w to 0.5	**Ochoa-Martínez et al., 2012**
4	Thawed frozen carrot puree	Effective length 1.83 m; air at 20^{0} C and 52% Relative humidity; temperature of hot water at 95^{0} C; belt speed ranging from 0.45 to 0.58 m/min	**Colour** Higher L, a, b & chroma values; more saturated red and yellow colors **Carotene retention** 8.7, 7.4 and 9.9% losses in total carotene, acarotene and bcarotene, respectively	**Abonyi et al ., 2002 Nindo et al., 2003**
5	Frozen strawberry		**Colour** Relatively brighter than fresh puree; higher hue and L values; superior to spray dried powder	**Abonyi et al., 2002**

6	Potato puree	Effective belt length and width of 1.83 m and 0.60 m, respectively; belt speed of 1.40 m/min; hot water temperature of 95^{o} C; puree thickness of 1 mm	**Colour** Higher saturation; chromaticity 12.2 ± 0.7; hue angle 293.6 ± 0.2; DE ¼ 36.49 ± 2.01	**Nayak et al., 2011**

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Weed management in rice-wheat cropping system

Article id: 22963

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Rice and wheat (RW) both are prevailing components of the Indian food security system as they are consumed as major staple food crops. Rice is a principal source of food for more than 50% of the world population, and more than 90% of rice worldwide is grown and consumed in Asian regions. The productivity of rice-wheat system is declining due to emergence of multinutrient deficiencies and building up of soil pathogens and weed flora besides increasing soil health problem. Weed control is a limiting factor in crop production. Weeds are probably the most ever-present class of crop pests and on the odd occasion cause massive crop failures over vast areas. They reduce the crop yield and deteriorate the quality and quantity of produce and hence reduce the market value of the turnout. They use the soil fertility, available moisture and nutrients, compete for space and light with crop plants, which result in yield reduction. The weed seed bank is the reserve of viable weed seeds present on the soil surface and scattered in the soil profile. It consists of both new weed seeds recently shed and older seeds that have persisted in the soil for several years.

Status of rice-wheat cropping system

Rice and wheat are the staple food crops, which have become the integral part of human diet of 800 million people in South-East Asia. The system spans four countries in the Indo-Gangetic Plains (IGP) region, Bangladesh, India, Nepal, and Pakistan, and occupies about 13.5 million ha. It accounts for about one-third of the area of both rice and wheat grown in South Asia, and it produces staple grains for more than 1 billion people, or about 20 per cent of the world's population.

Management practice for control of weed seed bank in rice- wheat system

Weed communities present within agricultural fields are the end results of the interaction of agronomic, environmental, and ecological selection pressures. The management of these factors and the potential for the introduction of new species are the determinants of community composition.

- **Rotation**

Diversification of the area under rice-wheat cropping system will not only bring changes in weed spectrum but will also create soil conditions unfavorable for *Phalaris minor*. Replacing wheat with alternate crops like berseem, potato, sunflower, gobhi sarson for 2-3 years in rice-wheat cropping system, the population of P. minor was found to be reduced significantly

- **Tillage levels**

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Tillage affects weed management, weed seed production and pattern of soil disturbances. *Phalaris minor*, which germinates from upper soil layers, can be buried by deep ploughing.

- **Use of herbicides**

A number of herbicides have been tested and recommended for effective weed control in wheat..

Herbicides	Dose (g/ha)	Time of application	Weeds controlled
2,4-D (Weedmar)	500-800	Post-emergence (30DAS)	Broadleaved weeds (Bathua, Hiranchari, Motha, Kasni, Krishnaneel, etc.)
Sulfosulfuron (leader)	25	Post-emergence (25-30 DAS)	Both broad-leaved weeds and grasses
Clodinofop-propagyl (Topik)	60	Post emergence (25-30 DAS)	Grasses
Fenoxaprop (Puma Super)	100	Post-emergence (25-30 DAS)	Wild oat and *Phalaris minor*
Metsulfuron Methyl (Algrip)	40	Post-emergence (25-30 DAS)	Broad-leaved weeds
Pinoxaden (Axial)	60	Post-emergence (25-30 DAS)	*Phalaris minor* & wild
Isoproturon (Arilon etc.)	750-1000	Post-emergence (25-30 DAS)	Grasses & Some Broad-leaved weeds

- **Increased crop density**

The role of increasing crop density in reducing competitiveness and seed output by weeds.

- **Sowing time**

The sowing time of crop should be adjusted so that it is maximum favorable for crop growth and development and least favorable for weed germination and growth e.g. to control P. minor in wheat.

- **Planting pattern**

Manipulating method of sowing to get even dense canopy also helps to control weeds by causing shading effects on weeds due to overcrowding.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Polyamine Function and Role in Abiotic Stress Responses

Article id: 22964

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Polyamines (PAs) are low molecular weight aliphatic nitrogenous bases containing two or more amino groups. They are widely distributed in eukaryotic and prokaryotic cells. They play important roles in diverse plant growth such as flower development, embryogenesis, organogenesis, senescence, and fruit maturation and developmental processes. PAs are play important role in cell division, cell proliferation and differentiation, cell death, DNA and protein synthesis and gene expression and have antioxidant properties. They are also involved in responses to biotic and abiotic stresses. Putrescine (Put), spermidine (Spd), and spermine (Spm), thermospermine (Tspm) and cadaverine (Cad) are the main PAs in plants. They are considered as a new kind of plant biostimulant. PAs improve plant's growth and productivity, and to provide a basis for future research on the mechanism of action of PAs in plant growth and development.

Polyamines are synthesized from the amino acid, arginine and converted into ornithine which will be converted to putrescine catalysed by the enzyme ornithine decarboxylase (ODC). Further to that, putrescine is converted to spermidine by spermidine synthase while spermidine is synthesized to spermine by spermine synthase. The synthesis of polyamine declines with age due to the decline in enzyme catalysing the reactions. Polyamines show tissue- and organ-specific distribution patterns in plants. For example, the most abundant PAs in leaves was found to be Put, and its levels were three times higher than those of Spd and Spm, whereas Spd was found to be the most abundant PAs in other organs.

The polyamine metabolism is connected to several important hormonal and metabolic pathways involved in development, stress responses, nitrogen assimilation and respiratory metabolism. Polyamine and ethylene biosynthesis are connected through SAM that acts as a common precursor. Antagonistic effects between these compounds occur during leaf and flower senescence, and fruit ripening. Polyamines induce the production of nitric oxide (NO) that may act as a link between polyamine mediated stress responses and other stress mediators.

Pas functions in tolerance and/or amelioration of stress in plants-

(i) PAs are serving as compatible solutes along with Pro, glycine-betaine and GABA;
(ii) Its interactions with macromolecules like DNA, RNA, transcriptional and translational complexes, and cellular and organellar membranes to stabilize them
(iii) Its role in directly scavenging oxygen and hydroxyl radicals and promoting the production of antioxidant enzymes and metabolites

(iv) PAs act in gas signal molecules in the ABA-regulated stress response pathway and through the production of H_2O_2
(v) Its regulators of several ion channels
(vi) PAs also participation in programmed cell death.
(vii) Its play important role in metabolic regulation of ammonia toxicity, nitric oxide (NO) production, and balancing organic N metabolism in the cell.

Polyamine accumulation occurs in response to several adverse environmental conditions, including salinity, drought, hypoxia, chilling, heat, ozone, UV-B and UV-C, heavy metal toxicity, mechanical wounding and herbicide treatment. The physiological implication of these responses remained unclear, and it had to be evaluated whether elevated polyamine levels were a result of stress-induced injury or a protective response to abiotic stress. Enhanced abiotic tolerance always correlated with raised levels of Put and/or Spd and Spm. Up-regulation of PAs biosynthesis in plants through transgene expression generally increases their tolerance to a variety of stresses. Using exogenous polyamine application also shows similar results and inhibitors of enzymes involved in polyamine biosynthesis, pointed to a possible role of these compounds in plant adaptation to several environmental stresses.

Polyamines, ROS (H_2O_2) and NO act synergistically in promoting ABA responses in guard cells. Polyamines are reported to promote the production of NO in Arabidopsis. Like ABA signalling pathway in stomata regulation which involves many different components such as ABA receptors, G-proteins, protein kinases and phosphatases, transcription factors and secondary messengers, including Ca^{2+}, reactive oxygen species (ROS) and NO; polyamines such as Put, Spd and Spm also regulate stomatal responses. In this regard, evidences point to an interplay between polyamines with ROS generation and NO signalling in ABA-mediated stress responses. The generation of ROS is tightly linked to polyamine catabolic processes, since amino oxidases generate H_2O_2, which is a ROS associated with plant defence and abiotic stress responses. ROS are capable of causing widespread damage to a variety of cellular metabolites as well as macromolecules. Increase in ROS production in stress tolerant plants is often accompanied by increased biosynthesis of antioxidants and associated antioxidant enzymes to ameliorate the ROS from cellular environment. The role of PAs in augmenting antioxidant based defense systems to impart tolerance against drought, heat, salt, heavy metals, UV and other stresses that are potent inducers of superoxide molecules causing oxidative damage to the living cells have been reported in several studies. Antioxidant enzymes can scavenge ROS to prevent membrane lipid peroxidation and stabilize membrane structure. Polyamines (Spm, Spd, and Put) can regulate the size of the potassium channel and the size of pores in the plasma membrane of guard cells, thereby strongly regulating pore opening and closing. Put treatment was shown to improve seed germination and increase all growth indexes like hypocotyl length, root and shoot fresh and dry mass.

CONCLUSION: The relationship between PAs and plant growth, development and stress tolerance are tightly linked. Roles of PAs in plant growth and developmental processes ranging from germination to flowering and flowering to senescence, are well discussed in various studies. Its also play important role in abiotic stress tolerant by enhancement the level of antioxidant metabolism.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Application of Hydrodynamic Cavitations in Food Processing

Article id: 22965

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''No additives and preservatives" and ''pure natural'' food concepts led to the development of novel technologies that are able to keep food safe and fresh with minimal thermal processing. Several non-thermal processing techniques were recently introduced in particular, high pressure processing (HPP), pulsed electric field (PEF), ultrasonic and irradiation. However, it was acknowledged that PEF could not provide food sterilization that is often required for industrial applications. The same conclusion was made about ultrasonic, which could provide partial microbial inactivation only in combination with thermal treatment. Food irradiation partially destroys harmful pathogens by damaging proteins and DNA; however, there is concern on the food safety after exposure to radiation (Martynenko et al., 2015). Cavitation is defined as the combined phenomena of the formation, growth and subsequent collapse of micro bubbles or cavities occurring over an extremely small interval of time (milliseconds), releasing large magnitudes of energy at the location of transformation. Very high energy densities (energy released per unit volume) are obtained locally, resulting in high pressures (in the range of 100–5,000 bar) and temperatures (in the range of 1,000–10,000 K), and these effects are observed at millions of locations in the reactor (Gogate, 2011). Cavitation is generally classified into four types based on the mode of generation, viz. acoustic, hydrodynamic, optic or particle, but only acoustic and hydrodynamic cavitation have been found to be efficient in bringing about the desired chemical/physical changes in processing applications, whereas optic and particle cavitation are typically used for single bubble cavitation, which fails to induce any physical or chemical change in the bulk solution. The spectacular effects of cavitation phenomena generated using ultrasound (acoustic cavitation) have been effectively harnessed in physical and chemical processing applications in food and bioprocessing industries (Martynenko et al., 2015). Capital cost, energy requirements and food safety are the most critical considerations for industrial acceptance of any novel technology. Another consideration is food texture, in particular highly viscous products, which narrows the choice of technology. Most of novel technologies, like HPP, PEF or UV, fall in the category of very expensive or high energy consumption. Only one of them (HPP, high temperature) is acceptable from the point of food safety requirements. Conventional and HTD technology are the most competitive and attractive for industry with respect to capital cost, energy requirements and food safety. Additional benefit of HTD processing as compared to conventional processing is product quality.

Hydrodynamic cavitation can simply be generated by using a constriction such as an orifice plate, venturi or throttling valve in a liquid flow. The pressure–velocity relationship of the flowing fluid as explained by Bernoulli's equation can be exploited to achieve this effect. At the constriction, kinetic energy of the liquid increases at the expense of pressure head as depicted schematically in Fig. 1, and if the throttling is sufficient to cause the pressure around the point of vena contraction to fall below the threshold pressure for cavitation (usually vapour pressure of the medium at the operating temperature), cavities are generated. Subsequently, as the liquid jet expands reducing the average velocity, the pressure increases, resulting in the collapse of the cavities. During the passage of the liquid through the constriction, boundary layer separation occurs, and a substantial amount of energy is lost in the form of a permanent pressure drop due to local turbulence. Very high intensity fluid turbulence is also generated downstream of the constriction; its intensity depends on the magnitude of the pressure drop and the rate of pressure recovery, which, in turn, depend on the geometry of the constriction and the flow conditions of the liquid, i.e. the scale of turbulence. The intensity of turbulence has a profound effect on cavitation intensity. Thus, by controlling the geometric and operating conditions of the reactor, the required intensity of the cavitation for the desired physical or chemical change can be generated with maximum energy efficiency. A dimensionless number known as the cavitation number (Cv) has generally been used to relate the flow conditions with the cavitation intensity.

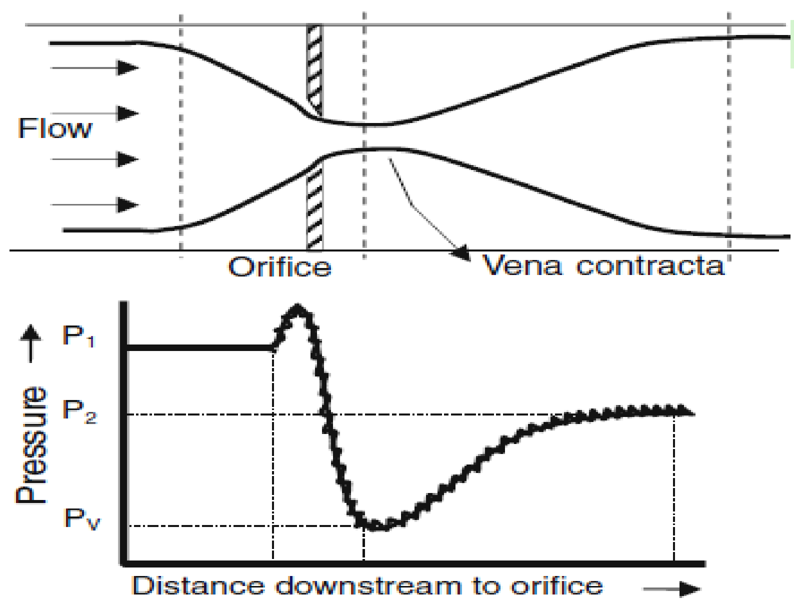

Fig 1: Fluid flow and pressure variation in hydrodynamic cavitation setup (Gogate, 2011).

Table 1: Cost, energy requirements and food safety of viscous food pasteurizers (Martynenko *et al.*, 2015).

Technology	Cost	Energy requirement (MJ/m^3)	Production cost (\$/m^3)	Food safety risk
Tubular pasteurizer	50-75000$	365-540	$10-15	Low
HDC	$15,000	300-430	$8-12	Low

HPP high temperature (95°C)	$1-3 million	13,350	$371.65	Low
HPP low temperature (5°C)	$1-3 million	5000	$138.07	Medium
PEF	$0.8-1 million	1000-2500	$30-70	Does not work on spores
UV	$15,000-30,000	700-1000	$20-30	Effective only on surface

A dimensionless number known as the cavitation number (Cv) has generally been used to relate the flow conditions with the cavitation intensity.

$$\mathbf{C_v = \frac{P_2 - P_v}{\frac{1}{2}\rho {v_o}^2}}$$

Where P_2 is the fully recovered downstream pressure, P_v is the vapour pressure of the liquid and v_o is the velocity of the liquid at the constriction. The cavitation number at which the inception of cavitation occurs is known as the cavitation inception number C_{vi}. Ideally, cavitation inception occurs at C_{vi}=1, and there are significant cavitational effects at C_v less than 1. However, cavitation has been found to occur at a higher cavitation number (in the range 2 to 4), also possibly due to the presence of dissolved gases or some impurities in the liquid medium. Cavitation can be achieved even at higher cavitation numbers, for maximum benefit from the reactor, the flow conditions and the geometry should be adjusted in such a way that the cavitation number lies in the range of 0.1 to 1, as very low operating cavitation numbers can lead to super-cavitation resulting in vapour locking and no cavitational collapse.

The turbulent pressure (P_∞) at existing downstream of the orifice can be calculated using the following formula

$$\mathbf{P_\infty = P_v + \frac{1}{2}\rho\{{v^2}_o - {v^2}_{td}\} - \Delta P}$$

Where v_o is the velocity of the liquid at the orifice, and v_{td} is the actual turbulent velocity at any point downstream of the orifice.

Velocity at the orifice can be calculated as

$$\mathbf{v_o = \frac{v_p}{n\beta^2}}$$

Where v_p is the pipe inlet fluid velocity, β is the orifice-to pipe- diameter ratio, and *n* is the number of holes in the plate.

Also the actual turbulent velocity at any point downstream of the orifice is given by the following equation:

$$\mathbf{v_{td} = v_t + v^{/} \sin(2\pi f_T t)}$$

Where V_t is the velocity of fluid downstream of the orifice, $v^{/}$ is the instantaneous fluctuating velocity f_T is the dominant frequency of turbulence (Gogate and Pandit, 2000).

Table 2: Optimum operating conditions for the hydrodynamic cavitation reactors (Gogate, 2011).

Property	Affects	Favourable conditions
Liquid vapour pressure (40-100 mm of Hg at 30°C)	Cavitation threshold, intensity of cavitation, rate of chemical reaction	Liquid with low vapour pressures
Viscosity range (1-6 cP)	Transient threshold	Low viscosity
Surface tension (0.03-0.072N/m)	Size of the nuclei (Cavitation threshold)	Low surface tension
Bulk liquid temperature (30-70°C)	Intensity of collapse, rate of the reaction, threshold/nucleation, almost all physical properties	Optimum value exists, generally lower temperatures are preferable
Dissolved gases • Solubility • Polytropic constant & thermal conductivity	• Gas content, nucleation, collapse phase • Intensity of cavitation events	Low solubility Gases with higher polytropic constant and lower thermal conductivity (monoatomic gases)

Table 3: Guidelines for selection of liquid physicochemical properties (Gogate, 2011).

Property	Favourable conditions
Inlet pressure into the system/rotor speed depending on the type of equipment	Use increased pressure or rotor speed but avoid super-cavitation by operating below a certain optimum value.
Diameter of the construction used for generation of cavities	Higher diameters are recommended for applications which require intense cavitation, whereas lower diameters with large number of holes should be selected for applications with reduced intensity.
% free area offered for the flow	Lower free areas must be used for producing high intensities of cavitation and hence the desired beneficial effects.

The comparison among different technologies used for food pasteurization in terms of cost of equipment, energy requirement and food safety is listed in Table 1.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 **Volume 2 – Issue 2 – February 2020**

"Sugarcane rust caused by *Puccinia erianthi*"

Article id: 22966

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INTRODUCTION :

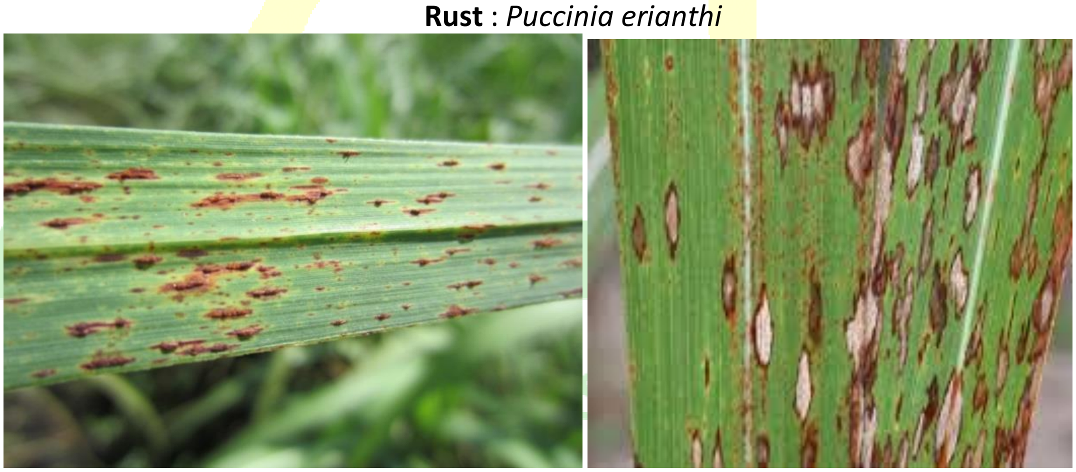
Sugarcane, *Saccharum officinarum* L., an old energy source for human beings and, more recently, a replacement of fossil fuel for motor vehicles, was first grown in South East Asia and Western India. Around 327 B.C. it was an important crop in the Indian sub-continent. It was introduced to Egypt around 647 A.D. and, about one century later, to Spain.

Botanically, sugarcane belongs to the Andropogonae tribe of the family Gramineae, order Glumiflorae, class Monocotyledoneae, subdivision Angiospermae, division Embryophita siphonogama. The subtribe is Sacharae and the genus, of course, Saccharum, derived from the Sanskrit "sarkara = white sugar", a reminder that the plant reached the Mediterranean region from India.

Diseases in sugcarcane

Ratoon stunting : *Leifsonia xyli subsp. xyli*
Grassy shoot disease
Rust : *Puccinia erianthi*
Sett rot : *Ceratocytis paradoxa*
Smut : *Ustilago scitaminea*
Wilt : *Fusarium sacchari*
Yellow Leaf disease
Red rot : *Glomerella tucumanensis*

Rust : *Puccinia erianthi*



e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Symptoms:

- The earliest symptoms are small, elongated yellowish spots that are visible on both leaf surfaces
- The spots increase in length, turn brown to orange-brown or red-brown in colour
- When the common rust is severe, numerous lesions occur on individual leaves giving them an overall brown or rusty appearance.
- These lesions coalesce to from large, irregular necrotic areas is usually result in premature death of the leaf. In such cases, the number of live leaves per plant can be seriously reduced.

Pathogen:

- Uredinia are elongate, reddish-brown, with capitate, hyaline to light brown paraphyses.
- Urediniospores are thick-walled, orange-brown. obovoid, measuring 26-34 x 16-20 µm. The Urediniospore surface is echinulate with 4-5equatorial pores.
- Teliospores are dark brown and measure 30-13 x 17-23 µm. clavate, two celled and slightly constricted at the septum.

Survival and spread

- The rust pathogen is transmitted by wind and water splash of the urediospores

Favourable conditions

- High humidity and warm temperature favours the development of diseases

Management strategies

- Grow resistant varieties
- Affected leaves should be remove and burn immediately
- Spray Tridemorph 1.0 litres or Mancozeb 2.0 kg/ha
- Application of triazole or strobilurin or pyraclostrobin fungicide @3g/ lit of water.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

An insight into Pesticide Compatibility

Article id: 22967

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In nature, insect pests and diseases occur simultaneously causing crop losses warning the farmers to take up effective control measures. As most of the pesticides are specifically toxic either to insect pests or pathogens, control of both with any single pesticide is not possible. Therefore, it is necessary to mix an insecticide with a fungicide/ bactericide and apply to a crop. By applying a mixture of two pesticides, the cost of control can be reduced provided if it does not cause an adverse effects on either the pesticides, crop growth or yield.

Generally, insecticides and fungicides are commonly applied at 5-7 days interval to manage insect pests and diseases. The judicious application of pesticides at the right time with recommended dosages makes them more effective. The end- users mostly ignore precautions and recommendations on the container label, which proves to be one of the main reasons for unsatisfactory performance of various fungicides, insecticides and herbicides. In economic point of view, the use of combinations of pesticides is a necessary practice especially in commercial agriculture and is widely followed by most of the professional fruit, flower and vegetable producers or growers in the country (Vidhyadhari, 2003).

The combination nor mixture of pesticides results in several problems.
In such cases, the components of a pesticide mixture are said to be "compatible" or "incompatible". The ability of two or more components of a pesticide mixture to be used in combination without impairment of toxicity, physical properties or plant safety of either of the components is known as compatibility. However, incompatibility is a condition that may arise due to the use of a combination of two or more pesticides with resultant loss or impairment of effectiveness of either component, development of undesirable physical properties, reduction of toxicity or the initiation of plant injury response (phytotoxicity) (Sharvelle, 1961).

Incompatibility of pesticides may be of following types:

D. **Physical incompatibility**
   The physical form of the pesticide changes, and one of them becomes unstable or hazardous for application (agglomeration, phase separation, explosive reaction, etc.).
E. **Biological incompatibility (Phytotoxic incompatibility)**
   The mixed product exhibits phytotoxic action, which independently is not phytotoxic.
F. **Chemical incompatibility**
   Chemical compounds in the two pesticides react with each other producing a different compound, reducing the pesticidal activity of the pesticides (Degradation of the active ingredient).

'Physical incompatibility' is when two or more pesticides are mixed and the result is an unstable mixture or a soapy flocculate. Usually, this may be visualized as layering or balling up or sediment formation affecting the efficacy of the pesticides. It can be caused by improper mixing, inadequate agitation or lack of stable emulsifiers in some emulsifiable concentrates. In most cases, solids settle out of the mixture or the mixture separates into layers after agitation. Sometimes, the mixture may curdle, gel or become sludge-like. Some poor mixtures develop when pesticides are mixed with hard water. A physically incompatible mixture may not be sprayable – and even if sprayed, the concentration will likely to vary during the application. Dikshitulu and Subbaratnam (1996) reported more sediment formation when permethrin was combined with carbendazim showing physical incompatibility. Manohar (2005) observed that endosulfan (EC) + hexaconazole, spinosad (SC) + hexaconazole and indoxacarb (SC) + hexaconazole were physically compatible.

In this test, initially take 500ml of standard hard water (0.304g calcium chloride and 0.139g of magnesium chloride hexahydrate in one liter of double distilled water) in a one liter jar to which add one insecticide and one fungicide/bactericide in the order:

7) Wettable powder (WP)
8) Dry flowables (DF)
9) Flowables (F)
10) Emulsifiable concentrates (EC)
11) Solubles designated as either solubles (S),
12) Soluble Liquids (SL), or soluble concentrates (SC).

The volume of insecticide and fungicide/ bactericide mixture is make up to one litre with hard water, agitate the mixture by shaking the jar and leave it undisturbed for 30 minutes. Record observations after 30 and 60 minutes with respect to foaming and sedimentation. Also, record the pH of insecticides, fungicides and bactericide alone and in combinations and categorise the mixtures in the scale given by Bickelhaupt (2012) as follows:

Scale	Category
< 4.5	Extremely acidic
4.5–5.0	Very strongly acidic
5.1–5.5	Strongly acidic
5.6–6.0	Moderately acidic
6.1–6.5	Slightly acidic
6.6–7.3	Neutral
7.4–7.8	Slightly alkaline
7.9–8.4	Moderately alkaline
8.5–9.0	Strongly alkaline
> 9.1	Very strongly alkaline

‘Biological (Phytotoxic) incompatibility ' is when two or more pesticides used in combination result in injury to the host plants. Some pesticides are safe when used alone, but injurious in combination. The symptoms of phytotoxicity include chlorotic spots (Peshney, 1990) and foliage injury (Arthur, 1960), darkened shallow pits on fruits (Poe and Jones, 1972), scorching and bleaching of foliage and reduced growth.

Biological (Phytotoxic) incompatibility can be tested in the semi-field conditions viz. in glasshouse and screen house under controlled atmospheric conditions. Record the observations from second to tenth days after spraying for phytotoxic symptoms such as injury to the leaf tip, yellowing, wilting, necrosis, vein clearing, epinasty and hyponasty on the leaves. The extent of phytotoxicity can be recorded based on the scale prescribed by the Central Insecticide Board and Registration Committee (C.I.B and R.C).

The per cent injury was calculated by using the formula:

$$\text{Per cent injury} = \frac{\text{Total grade points}}{\text{Max.grade} * \text{No. of leaves observed}} * 100$$

Leaf injury was assessed by visual ratings in a 0-10 scale i.e.

Scale	Phytotoxic symptoms(%)
0	No phytotoxicity
1	1 to 10% phytotoxicity
2	11 to 20% phytotoxicity
3	21 to 30% phytotoxicity
4	31 to 40% phytotoxicity
5	41 to 50% phytotoxicity
6	51 to 60% phytotoxicity
7	61 to 70% phytotoxicity
8	71 to 80% phytotoxicity
9	81 to 90% phytotoxicity,
10	91 to 100% phytotoxicity

'Chemical incompatibility' is when two or more pesticides are mixed, there is a resultant loss or reduction of effectiveness of one or all components. For this reason, most of the organic pesticides should not be used in combination with alkaline compounds having pH > 7.0. Alkaline reactions usually reduce the fungitoxicity of carbamate fungicides. In chemical incompatibility, the activity of the mixture may be different than if the products were applied separately. The results can be either increased activity called synergism or decreased activity which is called antagonism. Rynaxypyr was found compatible with carbendazim plus mancozeb and can be safely used as a tank mixture for management of simultaneous infestation rice insect pests and diseases without any phytotoxic effect on rice (Seni *et al*., 2018).

Synergism is produced when the association of fungicides with insecticides leads to a joint action that is superior to the arithmetical sum of actions exercised by the single fungicide or insecticide. Ali and Singh (2003) showed synergism of mancozeb + endosulfan mixture which resulted in increased efficacy of fungicide against the C*ercospora* leaf spot of sesamum. Antagonism is the condition found when the efficacy of the association is below the arithmetical sum of actions expressed by the single fungicide or insecticide. The combination of monocrotophos with mancozeb showed decreased insecticidal activity against red cotton bug (Lakshminarayana and Subbaratnam, 2000). When the pesticide mixture yields neither increased nor decreased efficacy than the arithmetical sum of actions expressed by themselves when used alone, such condition is said to be showing independent effect upon mixing. Peshney (1990) reported no change in the activity of resultant pesticide mixture of carbendazim and carbaryl when used against *Myrothecium roridum* compared to their effects when used alone.

CONCLUSION

The multiple pest management can be achieved through the use of two or more pesticides, fungicides or even fertilizers and their application in the same operation in order to reduce the labour cost. The physical and chemical properties of the pesticides, fungicide, fertilizers should be well understood prior to their mixing. The incompatible pesticides should not be mixed and only the compatible pesticides can be mixed.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Botanical derivarives against stored insect pests

Article id: 22968

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INTRODUCTION

Plant Essential oils:

Secondary metabolites in plants are believed to be involved in defence mechanism against phytophagous insects. These compounds, referred as essential oils, were extracted and extensively reasearched for their insecticidal properties. Essential oils are usually extracted from various plant parts *viz*., bark, leaf, flower, bud, seed, tuber and rhizomes. They are biodegradable and less toxic to non – target organisms The methods used for oil extraction are (i) ultrasound, microwave – assisted super critical fluid extraction and (ii) hydro or steam distillation methods. They comprises complex mixture of mostly terpenoids (mono and sesquiterpenes) and a variety of aromatic phenols, oxides, ethers, alcohols, esters, aldehydes and ketones Even though essential oils are biodegradable and having minimum toxicological effect, commercial availability is limited because of (i) the scarcity of the natural resource (ii) the need for chemical standardization and quality control and (iii) difficulties in registration of these materials as insecticides.

Essential oils and their action against stored product insects

Essential oil	Scientific name	Action	Activity	Insect pest
Ajwain	*Carum copticum*	Fumigant	1,8-cineol	Eggs, larvae and adult of *Sitophilus oryzae*
Thymus	*Thymus percicus*	Fumigant	Cinnamaldehyde	*Callosobruchus maculatus*, *Tribolium castaneum* and *Sitophilus oryzae*
Dhania	*Coriandrum sativum*	Fumigant		*Tribolium castaneum*
	Vitex pseudonegundo	Fumigant		Egg, larvae and adult of *Callosobruchus maculates*
	Laurus nobilus	Fumigant		All life stages of *Tribolium castaneum*

Rosemarry	*Rosmarinus*	Fumigant		Egg larvae and adult of *Tribolium castaneum*
Garlic	*Allium sativum*	Fumigant	Diallyl sulphate	Adult *Tribolium castaneum*
	Aillanthus altissima	Fumigant and Repellent		
				Adult of *Sitophilus oryzae*, *Oryzaephilus surinamensis*, *Tribolium castaneum*
	Schinus molle	Fumingant	Limonin	Adult of *Sitophilus oryzae*
	Mentha longifolia	Fumingant		All life stages of *Sitophilus zeamais*
Eucalyptus	*Eucalyptus nicholii*	Fumigant	Cineole	Adult of *Tribolium castaneum* and *Rhizopertha*
Neem	*Azadirachta indica*	Fumigant		Adult of S. oryzae and *Rhizopertha dominica*
Cardamom	*Elletaria cardamomum*	Fumigant		Ovipositin inhibition of *Callosobruchus* sp
Clove	*Syzigium aromaticum*	Fumigant		larvae of *Corcyra cephalonica* and *Tribolium castaneum*

Plant powders:

Treating plant leaf powders, seed powder and bark powder with seeds is an traditional practice to prevent insect invasion during storage Plant powders can be admixed directly with seeds or used as a bio-fumigant or impregnated with bags meant for seed storage. Several studies reported that plant products are said to have contact toxicity, repellent activity, oviposition deterrent and adult emergence inhibition activity, ovicidal activity, larvicidal and pupaecidal activity and feeding deterrent.

List of plant powders and extracts effective against stored product insects

Plant species	Target insect species	Effect
Acorus calamus rhizome	*C. maculatus*	100 % mortality within 8 days at 1 % concentration
Syzygium cumini leaf	*C. chinensis*	34.98 % mortality after 5 day

Pongamia pinnata leaf	*C. chinensis*	73.1 % mortality after 48 h at 20 mg/g concentration
Azadirachta indica leaf *A. indica* bark	*C. maculatus*	50 % mortality at 0.25 g/20 g concentration
Vitex negundo leaf	*C. maculatus*	86 % mortality after 72 h at 6 % concentration
Acorus calamus seed	*C. chinensis*	LD_{50}-6.59 µg/cm (48 h)
Chenopodium ambrosioides leaf	*C. maculatus*	LC_{50}-1.21 g/l (48 h)
Tithoria diversifolia bark	*C. maculatus*	100 % mortality after 3 day

CONCLUSION:

Essential oils were extracted from various plant parts *viz*., bark, leaf, flower, bud, seed, tuber and rhizomes are effective against storage grain pests and its eco friendly pest management against stored products.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Entomopathogenic nematodes

Article id: 22969

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Entomopathogenic nematodes are considered as the important bio-control agents for controlling of several agriculture important pests. *Steinernematidae* and *Heterorhabditae* are considered as important families in the entomopathogenic nematodes group (Kaya and Gaugler1993). Six life stages are present in the entomopathogenic nematodes. Life stages - Egg, J1, J2, J3, J4 and adults. Among these life stages, J3 is the infective stage of nematodes. It enters to the host by natural openings via vulva, excretory pore and spiracles. With the help of labial tooth , *Heterorhabditae* enters to the insects.

Important species of entomopathogenic nematodes:

- *Heterorhabditis indica*
- *H. bacteriophora*
- *H. megidis*
- *H. zealandica*
- *Steinernema glaseri*
- *S. carpocapsae*
- *S. thermophillium*

Two different types of bacteria mutually associated with the intestinal region of J3:

- *Xenorhabdus* (Present in *Heterorhabditis* spp.)
- *Photorhabdus* (Present in *Steinernematids* spp.)

Nematode infected larvae shows brick red and black in color due to the presence of bacteria.

Host suitable for entomopathogenic nematodes:

Several final instar larvae of lepidopteron and coleopteran groups are suitable for mass multiplication of entomopathogenic nematodes (Gaugler, 2002). Rice moth, *Corcyra cephalonica, W*hite grup, *Popillia japonica* and Wax moth, *Galleria mellonella* acts as a good host for entomopathogenic nematodes.

Culturing of entomopathogenic nematodes:

- *In- vitro* methods
- *In-vivo* methods

***In-vivo* methods:**

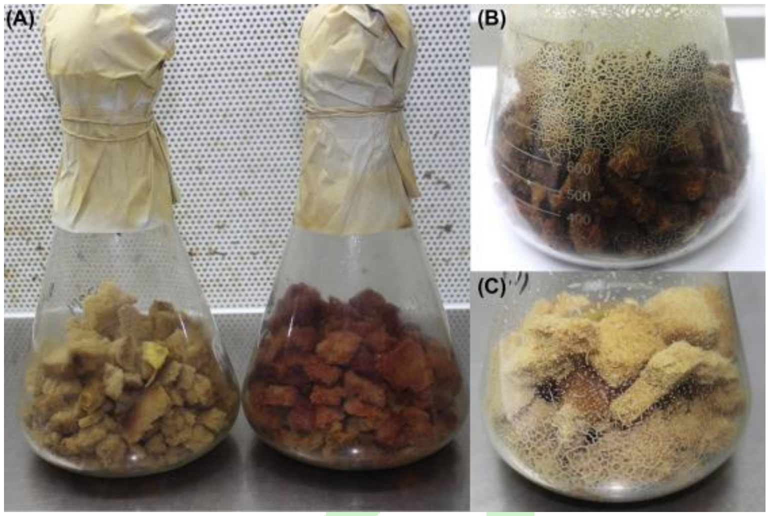
A Whatmann No.1 filter paper was placed in the bottom of a 9cm Petri plate. About one ml (200 IJs) of nematode suspension were inoculated on the filter paper. After inoculation of nematodes, ten larvae of rice moth, *C. cephalonica* were placed on the filter paper. These plates were sealed with Klin film and incubated for three and five days respectively for *Steinerma* spp. and *Heterorhabditis* spp. Only *S. glaseri* infected larvae were transferred to the modified White's trap (Woodring, 1988) three days after inoculation while *Heterorhabitis* spp. and *Steinermema* spp*.* infected larvae were transferred to the White's trap (White, 1927) five days after inoculation. The infective juveniles (IJs) of *Steinerma* spp. emerged out from the infected insect larvae on the 3rd day after inoculation while IJs of *Heterorhabitis* spp. emerged out on the 5th day of inoculation. The IJs were washed with the sterile distilled water four times and then excess water was decanted. The nematode suspensions were stored in a BOD incubator (Genuine model) at 20° C. A drop of Triton X was added to nematodes suspensions to avoid stickiness of nematodes.

White trap

Modified white trap

***In- vitro* methods:**

In vitro culturing of entomopathogenic nematodes is based on introducing nematodes to a pure culture of their symbiont in a nutritive medium. Significant improvements in *in vitro* culture utilizing large fermenters are used to produce large quantities of entomopathogenic nematodes for commercial use.



- ***In- vitro* method**

Formulation of entomopathogenic nematodes:

- Polyurethane sponges
- Water-dispersible granules
- Vermiculite
- Alginate gels

CONCLUSION:

Entomopathogenic nematodes are considered as the effective biological organisms. During field application, their survivability was low because it cannot tolerate UV light. So, it is not popularized among farmers community.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

The Food Security Challenges

Article id: 22970

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Food security occurs when all people are able to access enough safe and nutritious food to meet their requirements for a healthy life, in such a way the planet can sustain into the future. Global food security will remain a worldwide concern for the next 50 years and beyond. At present scenario, yield of crop has fallen in many areas due to various reasons like declining investments in research and infrastructure, as well as rising water scarcity. However, food security faces a number of challenges across both production and consumption which research will be essential to solve.

Now a day's most of the countries are suffering from dual burdens like hunger and under nutrition beside overweight and obesity, with one in three people across the globe currently suffering from some form of malnutrition. Indeed it is not unusual to find people with different forms of malnutrition living side-by-side in one country, in one community, or even in the same household.

The dominance rates of overweight, obesity and diet-related non-communicable diseases (NCDs) such as cardiovascular disease, stroke, certain cancers, are increasing in every region, in both developed and developing countries. Worldwide most of the people who are overweight or obese than underweight, with the two mutual accounting for more than half of the world population: a new normal. At the same time, around 795 million people suffer hunger on a daily basis and more than 2 billion people be deficient in essential micronutrients (*e.g*. iron, zinc, vitamin A), affecting their health and life expectancy. Nearly a quarter of all children aged under five today are stunted, with diminished physical and mental capacities, and less than one third of all young infants in 60 low and middle income countries meet the least nutritional diversity standards needed for growth. Climate change will only make things worse as elevated levels of CO_2 reduce the nutritional content of grains, tubers and legumes, affecting key nutrients such as zinc and iron. The estimated impact of under nutrition on gross domestic product (GDP) is 11% each year more than the yearly economic recession caused by the worldwide monetary crisis.

It has been estimated that we need to produce more food in the subsequently 35 years than we have ever produced in human history, given the projected increases in world population, and on the basis that rising incomes will continue to change diets. However, there is no new land for agriculture, with rising competition from urbanization (the world will be 70% urbanized by 2050), sea level rise reducing land availability, and the growing need for land for bio energy, carbon capture and storage (BECCS) to remove greenhouse gases (GHGs) from the atmosphere. This implies sustainable intensification of agriculture on the land that is available (*i.e.* produce more without expanding the agricultural area).

Food production is eventually dependent on other ecosystem services so it is essential that these are maintained. For example, near about 70% of all fresh water consumes agriculture sector, and produces around one third of all GHG emissions, and much influence to biodiversity loss and soil degradation (about 69% of agricultural land is degraded). If food demand continues to grow as projected, by 2050 it is predicted that we would need 120% more water, 42% more cropland, lose 14% additional forest, and results 77% more GHG emissions. It is clear that we will need to use every technology available, alongside best practice farming to sustainably increase production, but this has to be accompanied by changes to food requirement including actions on both consumption and waste.

The Paris Agreement commits signatories to keeping the increase in global average temperature to well below 2°C above pre-industrial levels, with an aim to limit the increase to 1.5°C. Emissions across all sectors therefore need to decrease by over 80% by 2050, with even greater reductions required for a 1.5°C target. It has been expected that on the present path, the food scheme will account for most of the GHG emissions budget for 2°C, leaving a minimum space for other sectors, and making it almost impossible to meet the Paris Agreement.

Gradual climate change will alter what can be grown and where, but the variability that makes up the average temperature and rainfall will lead to climatic shocks (heat waves, cold snaps, droughts and floods), significantly reducing yields. Our report estimates that the risk of these kinds of extreme weather events hitting multiple major breadbasket regions of the world at the same time could triple by 2040. This results in a loss of yield that is channeled downstream via market and policy responses into food price spikes, and in some cases civil unrest. Climate change can also alter the distribution and severity of pests and diseases in crops and livestock and has the potential for severe impacts on food production and animal welfare. In present scenario approximately one third of the global food produced for human consumption every year gets lost or wasted, whether early in crop production constraints like pests and diseases and post-harvest losses, or delayed in the supply chain at retail and consumption. This impacts on how much we might need to produce in the future. A major challenge understands how we can re-design the food system to be healthy, sustainable, and more resilient to climate change, helping to meet both the Sustainable Development Goals and the Paris Agreement.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Metabolomics: A useful tool to study the metabolic process of plants in response to abiotic stress

Article id: 22971

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INTRODUCTION:

The term ‘‘metabolomics’’ is referred to as comprehensive and quantitative analysis of all small molecules in a biological system. The metabolome of plants comprises the complete set of low-molecular weight metabolites (such as primary metabolites which are directly involved in necessary metabolic processes as intermediates, hormones and other signalling molecules, as well as secondary metabolites) in a given organism, a biological cell, tissue, or organ at a certain point in time and development. Since a long time, primary and secondary metabolites were considered as the end-products of gene expression and protein activity. Metabolomics is a powerful tool to acquire a comprehensive perspective of how metabolic networks are regulated and has indeed been applied. Study of metabolomics can be used to explain the functions of genes as a tool in functional genomics and systems biology approaches. The current development and adoption of metabolomics and systems biology approaches provide us comprehensive overview of metabolic responses of crucial components of plants to abiotic stresses. There are several techniques used in plant metabolomics research which will be discussed.

Techniques used for plant metabolomic research:

Gas chromatography-mass spectrometry (GC-MS):

It is one of the most widely used techniques for plant metabolomics research. Polar metabolites are derivatized to render them volatile and then separated by GC. Use of GC-MS is limited for thermally stable volatile compounds, making analysis of low molecular weight compounds. GC-MS is used for identification and quantification of sugars, sugar alcohols, amino acids, organic acids and polyamines, coverage of the central pathways of primary metabolism.

Liquid chromatography (LC)-MS:

LC has the ability to analyse a wide variety of metabolites in plants and it has no limitation like GC-MS. The recently developed Ultra performance liquid chromatography (UPLC) makes the technique more powerful and advanced than high-performance liquid chromatography (HPLC). LC-MS works on the principle of a reverse phase column to analyse secondary metabolites because of its ability to separate compounds with similar structure and to detect a wide range of metabolites.

Capillary electrophoresis (CE)-MS:

Capillary electrophoresis separates polar and charged compounds on the basis of their charge-to-mass ratio. One of the unique properties of CE-MS is the requirement of very small amount of sample for analysis; only nanolitres of sample are introduced into the capillary. Since both CE and LC have different mechanisms to separate a large variety of metabolites, combination of these may provide a wider coverage of metabolites.

Nuclear magnetic resonance (NMR) spectroscopy:

It is a MS-based technique being related to atomic interaction. This method of measurement is simple and non-destructive. NMR makes the possibility of analysing the metabolite composition of a tissue extract, determining the structure of a novel metabolite, demonstrating the existence of a specific metabolic pathway in vivo, isotope labelling experiment and localizing the distribution of a metabolite in a tissue. In a strong magnetic field, atoms with non-zero magnetic moment including ^{1}H, ^{13}C, ^{14}N, ^{15}N and ^{31}P absorb and re-emit electromagnetic radiation. The radiation is characterised by its frequency (chemical shift), intensity, fine structure and magnetic relaxation properties, all of which reflect the precise environment of the detected nucleus. Therefore, atoms in a molecule give a specific spectrum of radiation that can be used for identification and quantification of metabolites within a complex biological sample.

Importance of Metabolomic studies of plant stress:

Several metabolomic studies with the main metabolic changes play very crucial role in all abiotic stresses. In this section, we discuss the importance of metabolomics studies of water stress, temperature stress, light stress, ionic stress and oxidative stress.

Metabolomics study revealed an important role for metabolic regulation including regulation of photosynthesis and accumulation of osmolytes in the drought stress response. Accumulation of many metabolites including amino acids such as proline, raffinose family oligosaccharides, erythritol and putrecine, c-amino butyrate (GABA) and tricarboxylic acid (TCA) cycle were noted during drought stress. The ABA pathway and role of intermediate molecules during drought stress can be well studied. Metabolite profiling has additionally been carried out in crop species exposed to water stress conditions. Several branched chain amino acids were observed in wheat, barley and tomato. The accumulation of amino acids, alanine, proline and GABA, and the phosphoesters, glucose-6- phosphate and glycerol-3-phosphate, were observed as well as changes in the levels of minor sugars and various organic acids were observed through the study of metabolomics during submergence or water-logging condition.

The metabolomic studies of cold acclimated plants revealed that the amount of metabolites was known to increase in Arabidopsis plants upon exposure to low temperature, such as the amino acid- proline and the sugars- glucose, fructose, inositol, galactinol, raffinose and sucrose. An increase in trehalose, ascorbate, putrescine, citrulline and some TCA cycle intermediates, was also observed. Metabolomics was also used to reveal the functions of specific genes in cold acclimation. Overexpression of CBF3, which is one of the C-repeat/dehydration responsive element-binding factor (CBF) transcriptional activators induced rapidly under low temperature conditions.

Under high light condition, metabolites of glycolysis, TCA cycle and oxidative pentose phosphate pathway were altered in their content, metabolic shift and enhanced the Calvin-Benson cycle to fix more carbon. In addition, elevation of glycine due to light stress indicated the activation of photorespiratory pathways. In response to UV-B light plants shows metabolic change and adapted that condition.

There are many metabolomic studies to assess the metabolic effect of salinity in a variety of crops and related plant species including cereals, legumes, vegetables etc. One of the examples is the increase of asparagine levels in the more tolerant genotypes, suggesting that the roles of asparagine metabolism in supporting core nitrogen metabolism may play a role in tolerance. Metabolomics study of heavy metal stress is also crucial for understanding the tolerance mechanism of plants.

To cope with oxidative stress, the metabolic network of plant cells must be reconfigured either to bypass damaged enzymes or to support adaptive responses. The accumulation of sugar phosphates related to glycolysis and oxidative pentose phosphate pathways (OPPP) suggested the rerouting of glycolytic carbon flow into the OPPP possibly to provide NADPH for anti-oxidative effort.

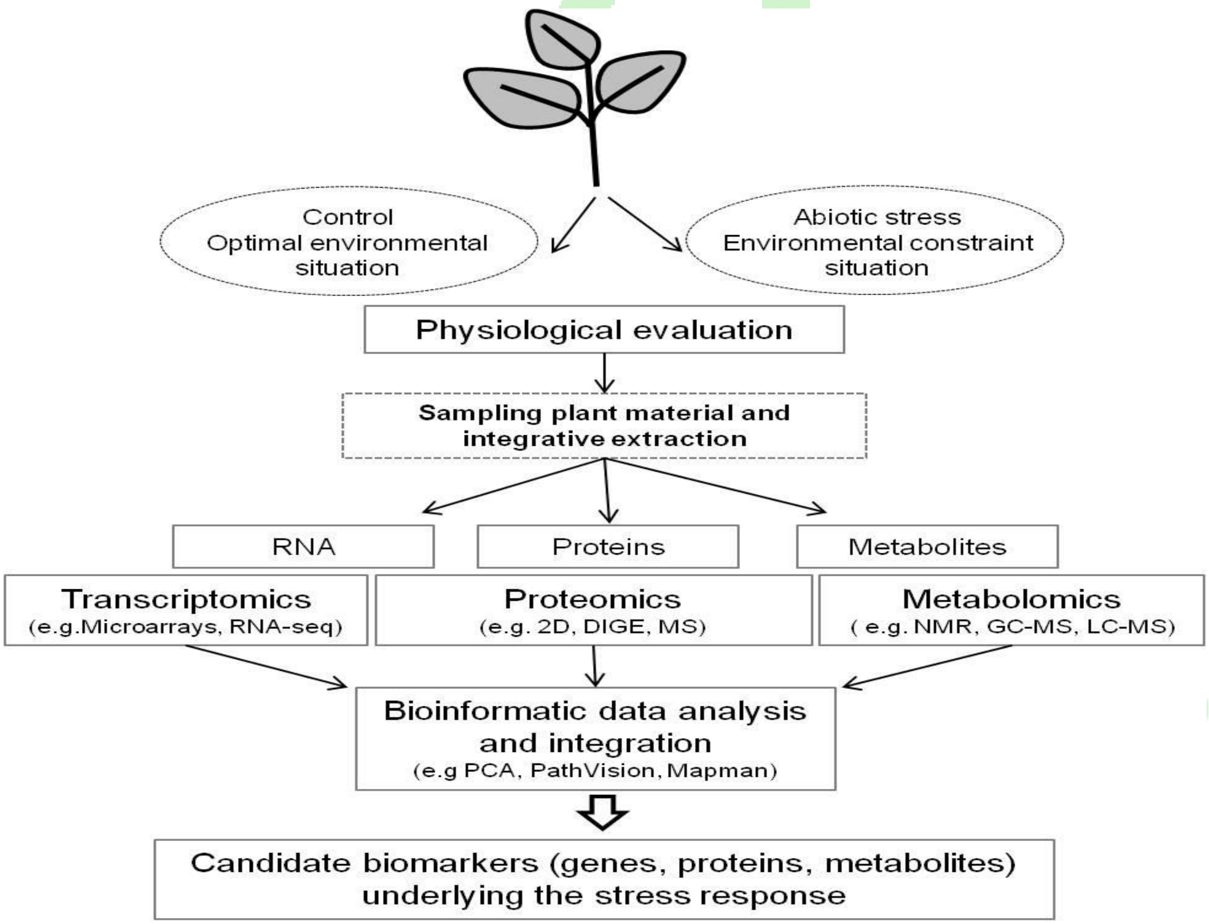

Fig 1: Schematic representation of holistic omics approaches for crop improvement (Figure adopted from review paper of Duque *et al*., 2012).

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

CONCLUSION:

Metabolite profile does not reveal exactly whether the related metabolic pathway is up or downregulated since both upregulation of upstream reactions and down-regulation of downstream reactions can lead to the accumulation of a metabolite. So, study of metabolomics along with transcriptomic or proteomic analysis or activities of specific enzymes can uncover several facts regarding abiotic stress study and show a clear cut idea of abiotic stress tolerance in plants.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317
Volume 2 – Issue 2 – February 2020

Pearl Millet Based Novel Foods

Article id: 22972

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Value addition of pearl millet levitates farmer's income with increased returns rather than selling it in the unprocessed form in the market. The value addition at the farm level itself address the post-harvest losses which accounts for majority of the losses the farmers are facing today. Processing of the pearl millets involves primary operations like wetting, dehulling and milling and secondary operations like germination, fermentation, malting, extrusion, flaking, popping, roasting and few other engineered food operations like pasta making, vermicelli preparation, energy and nutrient dense (END) foods preparation etc. are few techniques to add value to the harvested pearl millet by processing interventions.

INTRODUCTION

Pearl millet, one among the collective group of nutri-cereals, accounts for nearly half the total worldwide production of nutri-cereals. It is most prominent and largely cultivated millet crop in India and Africa. Pearl millet has higher fat, higher energy and high protein (better quality protein). Pearl millet is an excellent source of phosphorus which is essential for the structure of body cells.

Due to the increased consciousness among the common masses, almost all the food manufacturing companies in the global village and mostly that of India, focussed on nutri-cereals which were the only alternatives to the 'Big-3 crops' like rice, wheat and maize. Many traditional foods and beverages are produced from pearl millet like doughs, porridges, gruels, non-alcoholic beverages, and beers. Novel foods ranged from extruded snacks to fermented foods and macaroni etc.

Novel foods

Jalgaonkar *et al.* (2019) developed pearl millet based pasta which is gluten free with low glycemic index. Sihag *et al.* (2015) developed pearl millet based weaning food which targeted the infancy and pre-school children to a larger extent. Expanded snacks prepared from the pearl millet whey protein concentrate by coextrusion process was reported by Yadav *et al.* (2014). Sumathi *et al.* (2007) developed pearl millet based extrusion cooked supplementary foods (fortified) for pre-school children which were in compliance with the Indian Standards Institution (1974). Nkama and Bulus Filli (2006) developed traditional staple food called Fura from pearl millet and grain legume floors.

Pearl Millets			
Food security	**Nutritional security**	**Safety from diseases**	**Economic security**
Combating hidden hunger	Rich sources of micronutrients and bioactive compounds	Low glycemic index, Gluten free	Climate resilient crop, sustainable income generation
Anti pest, resistant to climatic stress and diseases	Iron, calcium, zinc, iodine, magnesium, manganese etc.	Prevents non communicable diseases (NCD's)	Low investment, high returns, Value addition
	Policy decision on inclusion of pearl millet based meals as breakfast and mid day meal will prevent anaemia in children and women		

Personal opinion

Central government should come up with a policy decision to ensure that multi-millet based breakfast meal should be provided to the masses aged upto 18 years (i.e., infancy to adulthood) as breakfast meal (wide ranging foods from weaning foods to adulthood foods etc.) through ICDS, School breakfast programme (A new initiative to be made alike noon day meal programme) etc., which addresses the nutritional security of the people of India. Infact the people of India are the future human resources who directly contribute the economic development of the country.

CONCLUSION

Novel foods developed from nutricereals address the nutritional security of the country and also levitate the income of the Indian farmer by processing the nutri-cereals at the farm level itself. The nutricereals consumption also contribute to the cognitive, emotional and social development of the common masses and majorly the age groups of upto 14 years.

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Functional insights into the LEA (Late Embryogenesis Abundant) proteins in Plants

Article id: 22973

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INTRODUCTION

Late Embryogenesis Abundant proteins (LEA proteins) are a group of hydrophilic proteins that accumulate at higher levels in plants which protect other proteins from aggregation during desiccation, seed dehydration associated with low temperature and at the end of embryogenesis. LEA proteins were initially discovered in cotton seeds in late embryogenesis stage and these proteins are abundantly found in pollens and seeds. LEA proteins can protect plants from desiccation, cold or high salinity. Its functional mechanism is different from the heat shock molecular chaperones. Although, the causes of LEA protein induction have not been determined, but predicted that it can potentially alter the conformation of transcription factors or integral membrane proteins due to water loss. LEA proteins specifically protect mitochondrial membranes from damage due to dehydration. Recent bioinformatics studies suggest that LEA proteins might behave as molecular chaperones.

Characteristics of LEA proteins:

- LEA proteins are highly hydrophilic.
- It prevents aggregation of proteins during dehydration and salt stress.
- These LEA proteins form coiled helix structure at the time of dehydration.
- Late embryogenesis abundant (LEA) proteins are mainly low molecular weight (10-30 kDa) proteins.

Classification of LEA Proteins:

- LEA proteins were classified in six groups (families) and it was based on their amino acid sequence and corresponding mRNA homology, which are basically localized in cytoplasm and nuclear region.

Functions of LEA proteins:

• LEA proteins are hydrophilic proteins with repetitive motives, accumulate to high levels in the later stage of seed development, and are also found in desiccation tolerant stage in other anhydrobiotes.
• Their abundance and expression profile strongly suggested their protective role in higher plants under different environmental stresses, especially in drought (dehydration).
• **The p**rotective role of LEA proteins can be better understood by combining biochemical, biophysical and structural modeling approaches.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

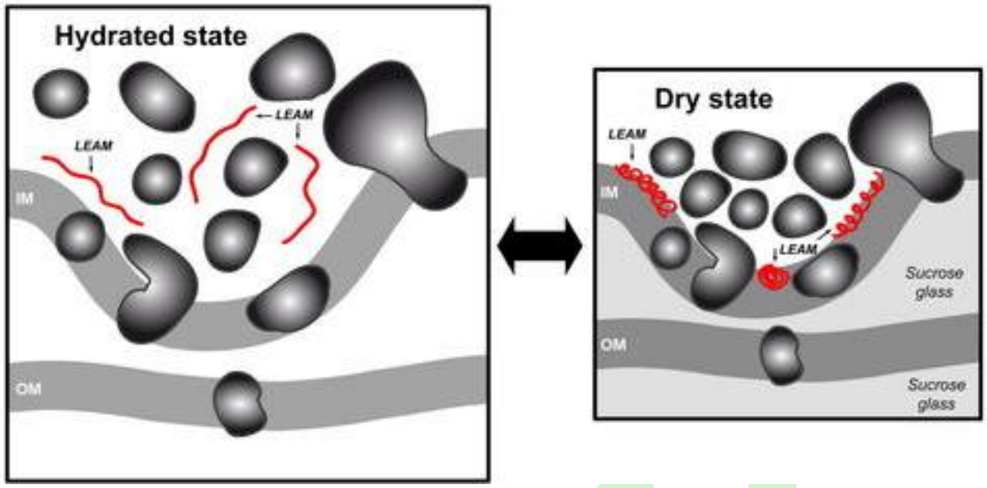

Fig.1. Action of LEA Proteins in membrane during dehydration stress

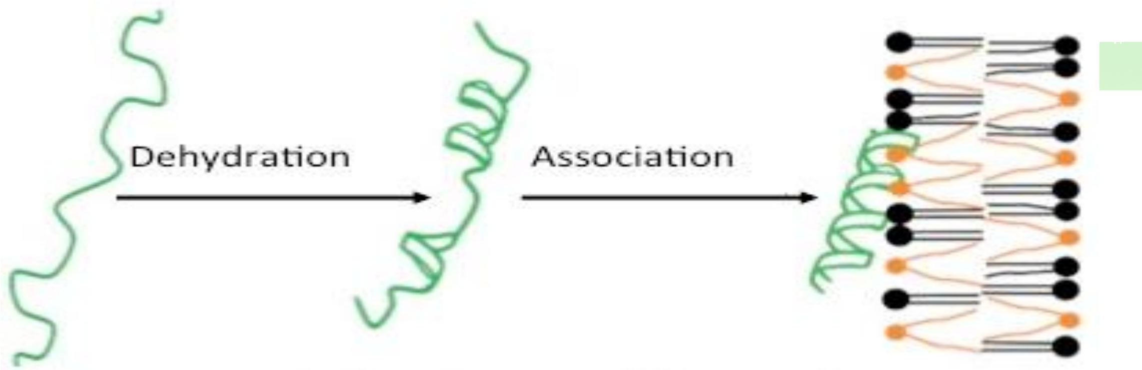

Fig.2. Protective mechanism of LEA Proteins

Gene regulation and expression:

• LEA genes encode a diverse group of stress protection proteins expressed during embryo maturation in all angiosperms. Most genes encoding LEA proteins have abscisic acid response (ABRE) and/or low temperature response (LTRE) elements in their promoters. Many genes containing the respective promoter elements were induced by abscisic acid, cold or drought. LEA protein synthesis, expression and biological activities are regulated by 51 genes encoding LEA proteins in arabidopsis.

• Level of LEA Protein expression depends on developmental stages, hormones, ion change and dehydration, signal transduction pathways of LEA genes.

• On the basis of extensive studies with the model plant, *Arabidopsis thaliana,* no tissue specific LEA gene expression has considered as main regulatory mechanism. Study of the regulatory mechanism of LEA gene expression is an important feature of modern plant molecular biology.

Importance and Future Prospects:

- The general importance of LEA proteins for anhydrobiosis.
- The bioinformatics approaches consisted in building an interactive database (LEAPdb) dedicated to the identification and *in silico* analysis of LEA proteins *(Hunault et Jaspard, 2010).*
- The over expression of genes encoding LEA proteins can improve the stress tolerance of transgenic plants. Expression of the barley gene *HVA1* in wheat and rice conferred increased drought tolerance to plants.
- Computational analysis led to a detailed and robust classification of LEA proteins.
- Scientists are currently using the resource to perform an in depth analysis of physicochemical properties of LEA proteins.
- Since plant genomes contain dozens of LEA genes and most of them have unknown functions, scientists started to explore the sub-cellular localization of the LEA proteins encoded by LEA genes in Arabidopsis (more than 50 genes). Such information is essential to perform functional studies and is an important contribution to genome annotation.
- Scientists currently combine bioinformatics approaches and transient expression of fluorescent protein fusions (GFP, RFP) in protoplasts and seedlings to resolve the distribution of the LEAome in different compartments.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Resilience of plant viruses to climate change

Article id: 22974
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This study focuses on the impact of ever increasing concern of climate change on the plants in general and on virus-plant pathosystem in particular by influencing interaction between hosts, plant viruses and their vectors. This study also helps us to understand how climate change shape a complete different scenario of plant virus disease epidemics by driving emergence of new viruses in a particular geographical region or by allowing a minor virus to become a more destructive one by changing the climate in its favour and rendering the prescribed management practices ineffective. It would also help us to understand the future steps to deal with this increasing yet newer menace for effective crop production.

INTRODUCTION

The word "Climate" generally conveys the meaning of average weather of a given region. Climate is an umbrella term encompassing the pattern of various meteorological factors such as temperature, atmospheric pressure, humidity, rainfall, wind, sunshine etc. in a given location or larger region over a large period of time (Gutierrez *et. al.,* 2010).

Any change in the climate either due to natural variability or as a result of human activity over time is known as climate change (IPCC, 2007) which ultimately alters the composition of the global atmosphere. These changes drastically affect the growth and cultivation of the different crops on the Earth. Simultaneously, these changes also pose a threat to our food security by affecting the reproduction, spread and severity of many plant pathogens. At the international level, World Meteorological Organization (WMO) in collaboration with the United Nations Environment Program (UNEP) established the Inter-governmental Panel on Climate Change (IPCC) in 1988, which has responsibility for assessing information relevant to climate change and summarizing this information for policy makers and the public. At the nation level, ICAR launched a network project i.e. National Initiative on Climate Resilient Agriculture (NICRA) in February, 2011.

Change in global climate and its general impact

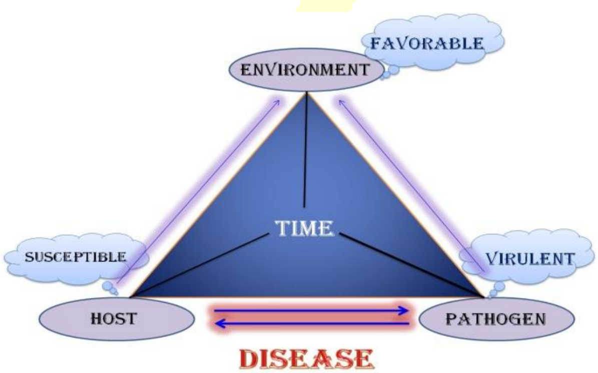
Rapid and continuous increase in the world population along with urbanization has led to the increased agricultural, economic and industrial activities as well as deforestation and habitat destruction. All these activities are responsible for increased emissions of gases like CO_2, CH_4, N_2O and O_3 etc. and increase in water vapour in the atmosphere leading to the

'Greenhouse Effect' resulting in warming of atmosphere, increased temperature, and changes in wind events and precipitation patterns. During last 100 years, global mean temperatures have increased by 0.74°C with its rate becoming even faster in recent years. Snow cover is continuously decreasing. It is also affecting the global agriculture by affecting crops, soils, livestock and pests either directly or indirectly. The increased temperature can reduce crop duration, increase crop respiration rates, alter photosynthate partitioning to economic products, affect the survival and distribution of pest populations, hasten nutrient mineralization in soils, decrease fertilizer-use efficiencies, increase evapo-transpiration rate, insect-pests will become more abundant through a number of inter- related processes, including range extensions and phenological changes, as well as increased rates of population development, growth, migration and over-wintering. An increase in atmospheric CO_2 level will affect fertilization of crops with C3 photosynthetic pathway and thus will promote their growth and productivity.

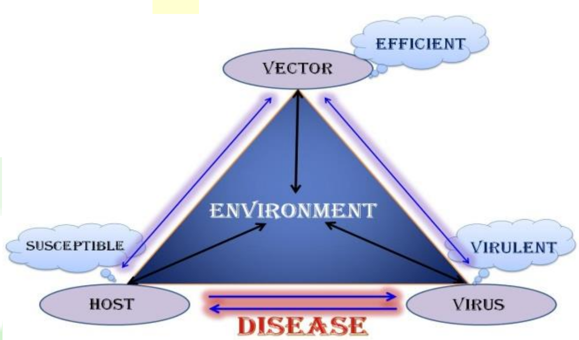
Development of disease in plant

A plant disease is the result of interaction among a susceptible host plant, one or more virulent pathogen(s) and the favourable environment. A change in the climate can influence the environment that range from microclimate to local, regional, sub-continental, continental and global. The effects of climate change on disease epidemics also need to be considered at all these levels.

However, with vector-borne pathogens, a vector must also be included making a disease triangle with the pathogen, the host and the vector in each of its corners, each interacting separately with the environment. This complicates things further because of additional interactions between environment and vectors, and between vectors and both pathogens and hosts. Thus, vector feeding can alter plant growth, thereby altering microclimate. Also, pathogen infection can modify host physiology and appearance to attract the vector, or a virus or mollicute may multiply within a vector resulting in altered vector behaviour.



Disease triangle



Virus disease triangle

Resilience of viral plant diseases to climate change

The climate change may affect the plant virus spread, primary infection, infection spread within the host and/or the horizontal virus transmission to new hosts by the vector, host's phenology and physiology thereby affecting its susceptibility to the virus and the ability of the virus to infect, as well as the geographical distribution and densities of alternative hosts/reservoirs. The change in host physiology may affect the host's attractiveness to vectors and/or viral transmissibility. It can also modify the geographic range of the potential vectors and/or vector phenology, as well as the vector's over-wintering, density, migration and activity. Climate change can also affect the virus stability, its replication and movement rates, as well as synergism and complementation between viruses. Increased CO_2 levels can indirectly influence the third trophic level, by modifying the size and composition of populations of prey insects available to predators and/or by disrupting developmental synchrony for parasitoids (Jones, 2009).

Effects of climate change on host plant

Increased CO_2 level can modify the plant structure like increase in the size of plant organs, increased leaf area, increased leaf thickness, higher numbers of leaves per plant, higher total leaf area per plant, and thicker stems and branches. During colder parts of the year, Warming may relieve plant stress during cold season but more stressed plants may be seen during hotter parts of the year. Plant responses during high temperature stress may be similar to those induced by water stress, with symptoms including wilting, leaf burning, leaf folding, abscission, and physiological responses including changes in RNA metabolism and protein synthesis, enzymes, isoenzymes, and plant growth hormones. Host plant physiology may be altered by influencing secondary metabolite pathways, thereby altering the nutritious value of leaves to insect vectors. The patterns of gene expression of defense signaling routes against some insect vectors may also be changed. The increased stomatal conductance may lead to increased photosynthetic efficiency. Virus multiplication within cells as well as its systemic movement and acquisition by insect vectors may be altered. Increased O_3 concentrations may change the properties of leaf surfaces by altering the physical topography as well as the chemical composition of surfaces, including the structure of epicuticular wax.

Effects of climate change on vectors

1. **Aphids**

Aphid vectors with short generation time and low developmental threshold temperatures, are expected to react strongly to climate change. In temperate type climate, the ability of aphid vectors to overwinter is likely to be increased by shorter cold spells and fewer days with frosts, allowing them to increase the duration of their activity annually and expand their geographical ranges. In temperate regions, temperature increase of 2ºC is likely to give rise to an extra five generations of aphids/year. In such zones, disease epidemics caused by aphid-borne viruses such as *Cereal yellow dwarf virus*, *Sugarbeet yellows virus* and *Potato leaf roll virus* are likely to be more severe. However, in Mediterranean-type climates and rain-fed winter cropping, the ability of aphid vectors to over-summer is likely to be reduced by the hotter, drier summer conditions, e.g. vectors of BYDV in parts of south-west Australia.

2. Whiteflies

Whitefly vectors are also expected to react strongly to climate change due to their short generation time, high reproductive capacity, and behavioral changes. *B. tabaci* and *T. vaporariorum* transmit different viruses. Whitefly vectors generally prefer warm conditions with *B. tabaci* being less cold tolerant than *T. vaporariorum*. In case of *B. tabaci*, 25–28°C is optimal for development, and much shorter adult-to-adult generation times occur at high (31–33°C) than low (17°C) temperatures. Because of increasing mean winter temperatures due to climate change in places formally too cold for it in winter, *B. tabaci* is tending to displace *T. vaporariorum.* This in turn, is influencing whitefly-transmitted virus distributions in different parts of the world, and damaging epidemics of *B. tabaci*-transmitted begomoviruses are becoming more widespread (Jones *and Barbetti*, 2012).

3. Thrips

Thrips vector populations may increase due to increased annual mean temperatures by speeding up their developmental rates leading to more generations per year as well as change their species composition. *Thrips palmi* may expand into areas previously too cold for it, displacing other thrips species adapted to cooler temperatures and likely to expand the ranges of damaging potato-infecting tospoviruses transmitted by it (eg, *Groundnut bud necrosis virus*) to regions formerly too cool for them. This may also happen to viruses transmitted by leafhoppers, mealybugs, and eriophyid mites (Jones, 2009; Jones *and Barbetti*, 2012).

4. Fungal Vectors

Temperate zones are going to be severely affected by the epidemics of soil-borne viruses with fungal vectors, whereas it would be less widespread in mid-latitude zones as these gradually become more prone to drought. eg. Decreasing incidence of pecluviruses in parts of India and Sub-Saharan Africa, and enhancing epidemics of viruses of cereals, potatoes and sugar beet in temperate regions of the world like cereals in Canada, northern Europe, north-east Asia and the southern cone of South America or in potatoes and sugar beet in northern Europe.

5. Nematode Vectors

Viruses transmitted by nematodes are likely to be more serious in temperate regions like Canada, Northern Europe, Russia, north-east Asia and the southern cone of South America. Conversely, incidence of these viruses will probably decline in rain-fed crops in mid-latitude zones due to declining soil moisture. Different vector nematodes species have different temperature requirement for feeding, hatching, reproduction and survival. The geographical expansion of nematode vectors in north is predicted to happen as for each 1^{o}C increase in temperature, a 160–200 km increase in nematode range is the most likely, potentially resulting in damaging outbreaks of *Raspberry ringspot virus* and *Strawberry latent ringspot virus* transmitted by *Xiphenema sp.* and *Longidorus macrosoma* respectively in raspberry and strawberry crops in the affected areas. Also in case of introduction of susceptible crop into new areas which were earlier too cold to grow them would increase frequency of viruses that

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

currently have restricted distributions, e.g. *Pea early browning virus* transmitted by *Trichodorus virulentis*.

Effects of climate change on viruses

In most of the virus–plant pathosystems, elevated mean temperature may increase rates of virus multiplication and systemic movement, leading to increased rate of symptom appearance and severity of virus disease. However, rise in temperature above a certain level has the opposite effect. It can influence the behaviour of viruses present in mixed infection. The geographical distribution of viruses having high-temperature requirement for multiplication within their host plants are likely to expand from the areas with tropical/subtropical climates they now occupy to areas of higher latitude that were earlier too cool for them and to previously cooler higher elevations in mountainous regions within the tropics/subtropics. But if the ranges of their vectors were to remain unchanged, such expansion would be limited and the opposite scenario is predicted for key tropical vectors of such viruses such as whiteflies and thrips. Conversely, viruses having lower-temperature requirement for multiplication within their host plants may contract their geographical ranges to areas of higher latitude or higher elevations in mountainous regions within the tropics/subtropics. Again, if the ranges of their vectors were to remain unchanged such expansion would tend to be limited, but the opposite scenario is predicted for key temperate region vectors such as aphids.

Effects of climate change on virus disease epidemics

In general, rising mean temperature and heat stress increase plant susceptibility to virus infection and decrease the level of temperature-sensitive single-gene resistances. Enhanced temperature also modifies rates of virus multiplication, its systemic movement, and seed transmission as well as affects the multiplication and systemic movement of individual viruses present in mixed infection. In addition, it modifies virus evolution rates and selection pressures leading to the development of virulent strains with broad host range, hastened virus multiplication rates in reservoir hosts, and enhanced vector transmission efficiencies, e.g. when tobacco plants infected with CMV were held at 25^{o}C and 33^{o}C, elevated temperature enhanced spontaneous mutations in the CP gene of the virus and altered virulence. It may also change the scale of virus epidemics by decreasing the effectiveness of temperature sensitive resistance genes when temperatures exceed a threshold (RAC Jones, 2009).

The magnitude of virus epidemics will certainly change as higher temperature in the growing region will alter selection pressures on the viruses and also alter virus evolution rates. There will be increased occurrence of 'new encounters' between viruses (and their vectors) and host plants due to the change in geographical distributions of crops, host range and geographic expansion of virus and vector distribution resulting from increasing temperatures and altered rainfall patterns which ultimately provide new opportunities for virus evolution and host species 'jumps'. This will further increase the rate of invasion of indigenous flora by introduced viruses and of introduced plants by indigenous viruses emerging from native plants to infect them (Garrett *et al*., 2006). However, in some situations change in climate may reduce the face-off between virus and host by changing their ranges so that they coincide less, e.g. in arid and semi-arid regions by reducing the total cropped area or diminishing the fragmentation of remnant native vegetation.

Factors driving emergence of viruses

The important factors influencing virus emergence and increased epidemic severity are:

1. **Major agricultural changes:** The major changes driving virus emergence include intensive agricultural practices like introduction of new crops and all-year-round cropping employing use of protected cropping, excessive use of chemical control measures and irrigation particularly in dry regions, loss of genetic diversity of crops; introduction of new weeds or crops that influence epidemics in other hosts.
2. **Alterations in biology:** Increased natural host range as well as greater adaptability to infect introduced hosts; introduction of new vectors/vector biotypes or variants of existing vector species; and circumvention of host defenses in introduced crops are some major factors driving emergence of new viruses.
3. **Molecular alterations:** Various modes of exchange of genomic segments such as genetic recombination, pseudo-recombination, reassortment and modular evolution often leads to switching of the host, expansion of host range and appearance of new virus diseases. Some other factors also play equally important role like selection from existing variants within virus populations; mutations; synergism; random drift due to geographical isolation; population bottlenecks and 'founder effects' associated with vector transmission or virus spread within individual plants; presence of satellite nucleic acids and satellite viruses; and integration of genome.

CONCLUSION

This study addresses the many complicated and geographically diverse ramifications of climate change likely to influence infections and epidemics of viral plant pathogens worldwide. Depending on the combinations of pathosystem, cultivation practices or ecologies concerned, each climate change parameter can influence plant hosts, pathogens and vectors directly. The important climate parameters here are alterations in temperature, rainfall, relative humidity and greenhouse gasses. In addition, complex climate-change-induced spatial and temporal shifts in crops, reservoir host and weed distributions and alterations in cultivation systems can influence hosts, pathogens and vectors indirectly. Alterations in climate may change diverse components of virus epidemics in many different ways, such as changing host appearance, its physiology and resistance against vectors or pathogens, life cycle of vector and virus, their abundance, diversity, reservoirs and inoculum. Though climate change seems may enhance virus epidemics in higher and lower latitude regions, it may have the opposite effect, especially in drying mid-latitude regions. Climate change would inevitably increase new encounter scenarios between cultivated and wild plants as temporal and spatial shifts in their distributions which would accelerate the appearance of epidemics caused by (i) new viruses emerging from indigenous vegetation to threaten newly introduced plants; and (ii) newly introduced viruses and vectors that come with newly introduced plants and invade native original plant communities. Also, climate change would lessen the effectiveness of some resistance genes, and viral disease epidemics would become more frequent, leading to difficulties in managing them successfully using current management technologies. So best management will be from exclusion or early detection and elimination wherever it is possible.

Future Prospects

Additional recommendations for future research that arise from this study are:-

1) More sophisticated, 'big picture', modeling studies to show the regions where climate change may result in serious viral disease epidemics where the pathogens concerned were previously considered of less importance.
2) Identify regions where new encounter scenarios would occur due to climate change induced temporal and spatial shift in crop, reservoir and weed host distributions.
3) More research is needed on the impact of climate change, particularly that of increased temperature, elevated concentrations of the greenhouse gasses, alterations in relative humidity, drought and flood on viral diseases and epidemics.
4) Experiments should be conducted in field situations.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Bacterial Quorum Sensing: A Potential Anti-Virulent Drug Target

Article id: 22975

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INTRODUCTION

The host-pathogen interaction is an ever going process and in that process, plants and animals have evolved several defense mechanisms to perceive pathogen attack and render them ineffective by activating defense responses against them (Dangl *and Jones*, 2001). On the other hand, several pathogens, particularly bacterial pathogens have developed different strategies to overcome host defense. Quorum sensing (QS) is one such strategy which is a cell to cell communication mechanism, often used by prokaryotes to monitor their own population density and to regulate the expression of virulence genes, and thus facilitates effective attacks (de Kievit *and Iglewski*, 2000). It was first observed in *Aliivibrio fischeri* which is a luminescent bacterium found in ocean. It produces blue-green light in squid but not in ocean. Because in water there population is 10^2 per ml but inside squid 10^{10} per ml. These quorum sensing systems also helps in regulating diverse functions in Gram-negative and Gram-positive bacteria, which include competence, plasmid conjugal transfer, biofilm formation, pigmentation, virulence factor, exo-polysaccharide production, antifungal or antibiotic production, bioluminescence, endoglucanase production, motility patterns, cross-signaling between strains and species etc.

Quorum sensing is mediated by various molecules or quorum-sensing signals (quormones) known as autoinducers which are released by many Gram-negative and some Gram-positive bacteria in the extracellular medium. The quorum-sensing bacteria produce, detect and respond to these small signal molecules. In all bacterial population when the concentration of these autoinducers exceeds a particular threshold value, a set of particular genes such as genes for virulence, stationary phase, competence *etc*. gets activated. In bacteria, several families of quormones that are implicated in the regulation of bacterial virulence have been identified in the past two decades (Cámara *et. al.*, 2002). Among them, acyl homoserine lactone (AHL) mediated quorum-sensing signaling is best characterized, most common and found in more than 50 Gram-negative bacteria species. The general mechanism of quorum sensing is widely conserved among bacterial species as shown by research findings from several well-characterized bacterial species including *Vibrio fischeri, Pseudomonas aeruginosa, Agrobacterium tumefaciens* and *Erwinia carotovora* (Miller *and Bassler*, 2001).

A quorum sensing mechanism generally involves the accumulation of AHL molecules in the extracellular environment and its subsequent transportation to the cognate transcription factor. A bacterial QS system can be divided into certain key functional components: signal generation, signal transportation and the signal perception. Recently a new component, a genetically controlled signal turnover system has been identified in *Agrobacterium tumefaciens* which facilitates bacterial cells to sense a change in growth and consequently to switch off the quorum-sensing machinery (Zhang *et. al.,* 2002).

Besides AHL, several other QS signaling molecules also acts as local sensors to regulate population density dependent gene expression in bacteria which are generally grouped into three major classes: N-acyl homoserine lactones (AHLs), which is oxidative state of the acyl side chain and produced by Gram-negative bacteria; autoinducing peptides (AIPs) or oligopeptides, consisting of 5-34 amino acids residues, which are generally used by Gram-positive bacteria; autoinducer-2 (AI-2), a ribose derivative [4,5-dihydroxy-2,3-pentanedione] used by both Gram-positive and Gram-negative bacteria for interspecies communication (Reading *and Sperandio*, 2006).

Commonly, the signal molecules AHLs from Gram-negative bacteria and AIPs produced by Gram-positive bacteria are very regularly engaged in quorum sensing signaling and have been studied extensively. Most of these QS signal molecules are chemically different and species specific, whereas some are known for inter-species communication. These QS signal molecules are having multiple roles to perform rather than just managing gene expression in producer strain as revealed by their biological properties. It is guessed that bacteria use these quorum sensing systems to listen the communication signals from other bacteria and use this information to its own benefit.

Quorum quenching

The process by which an autoinducer-mediated quorum sensing is interrupted is known as quorum quenching. Quorum sensing generally facilitates community-based behavior in bacteria, but it is not essential for their survival or growth. Thus, interruption with quorum sensing may lead to the inhibition of desired phenotypes. Most of the plant pathogenic bacteria are Gram-negative and employ AHLs-mediated QS as their major language to coordinate population behavior (Dong *et. al.*, 2007). Since quorum sensing plays active role in biofilms formation and virulence gene expression, bacterial diseases can be managed effectively without killing or inhibiting bacterial growth by targeting quorum sensing. There are several strategies available through which the quorum sensing can be interrupted such as; i) Inhibition of AHL synthesis by blocking the LuxI-type synthase proteins ii) Enzymatic destruction of AHLs molecules by AHL-acylase, AHL-lactonase and AHL-oxidoreductases and iii) Interference with signal receptors or blockage of formation of AHL/LuxR complex by different chemical molecules. Additionally, quorum quenching has earlier proven to be a primary target both for quorum sensing signal synthase and sensor or response regulator proteins involved (Uroz *et. al.*, 2009).

Some example of inhibiting quorum sensing for plant disease management

Quorum quenching for plant disease management was first time used when the *aii*A gene from *Bacillus* sp. cloned into transgenic tobacco and potato plants. The genetically modified plants expressing this gene production of AHL-lactonase by paralyzed quorum-sensing systems of the phytopathogenic bacterium, *Erwinia cartovara.*

Another approach is to construct transgenic tobacco plants expressing *E.carotovora* AHL gene. Ectopic production of bacterial AHL by the transgenic plants tricks the pathogen into prematurely secreting virulence factors, such as pectinolytic enzymes, when cell populations are insufficient for infection. This is thought to trigger host plant defenses resulting in the observed disease resistance.

Even some wild-type soil bacterium with AHL-degrading capability can be used for the biocontrol of plant diseases. *Bacillus* sp. strain A24 is able to degrade AHLs produced by plant pathogenic *E. carotovora* and *A. tumefaciens* and it exhibits broad-spectrum activity by significantly reducing diseases of potato and tomato caused by these phytopathogenic bacteria. It has established that AHL degradation has preventive as well as curative biocontrol activity. By staggering the application of pathogenic *E. carotovora* and AHL-degrading bacteria, they found that even when the pathogen was given a 2-day head start to establish and initiate disease symptoms, subsequent application of an AHL-degrading strain stopped further disease development. This has practical implications for those bacterial diseases that typically incubate before any outward symptoms manifest themselves. In such cases, it may be possible to implement treatment measures after disease has already set in.

CONCLUSION

The broad-spectrum activity of AHL degradation that was observed against bacterial pathogens, which rely on quorum sensing for disease development, had its limits when applied for control of a fungal pathogen that does not utilize AHL signals. Management practices for the bacterial pathogen uses several antibiotics, the higher use of which has led to the resistance development in bacterial pathogens. Quorum quenching is a potential new approach for plant disease management. QQIs can be potential alternative of antibiotics in most of the cases or can be used along with them synergistically to increase efficacy. Use of QQ enzymes for plant disease management can also be a new area of research where transgenic plants can be developed producing these enzymes. Further research is needed for potential exploitation of this methodology.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Epiphytotic emergence of minor diseases: A critical overview

Article id: 22976

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INTRODUCTION

In the past two decades, emerging and re-emerging plant diseases have posed new threats to food production. Emerging diseases are those which always been present in an area but have grown in importance over the years. Re-emerging diseases are those that have been previously controlled but are once more a major problem. Emerging infectious diseases (EIDs) are those disease which are caused by the pathogens which are either discovered and/or recognized newly or their properties have changed significantly like increase in incidence, geographical or host range or change in pathogenesis or they might have evolved newly. EID Pathogens can be grouped into four classes like (i) New pathogens which are reported within last five years, (ii) Emerging pathogens whose incidence have shot up dramatically within last 20 years (iii) Re-emerging pathogens which are showing chemical resistance or change in management or cultivars (iv) Threatening pathogens which are not reported or their distribution is limited.

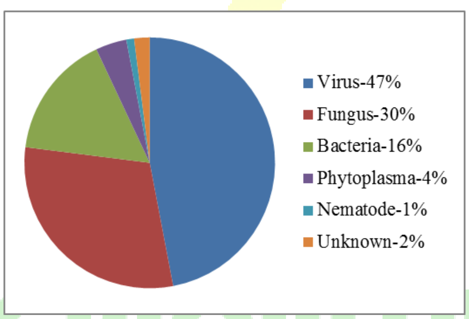

Fig.1 (a)

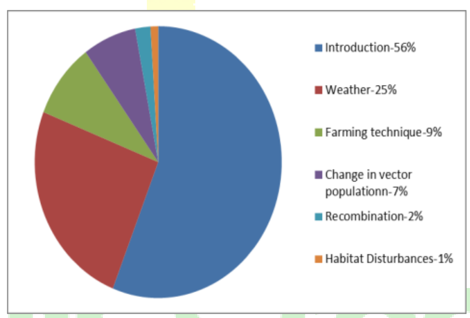

Fig.1 (b)

Figure 1(a) represents pathogens causing plant EIDs while figure 1(b) represents factors responsible for emergence of plant EIDs.

Among the fungal diseases, bakanae and false smut of rice, spot blotch, karnal bunt, and yellow rust of wheat are serious. Likewise bacterial diseases such as bacterial panicle blight caused by *Burkholderia glumae* and other diseases caused by *Pseudomonas, Acidovorax* and *Burkholderia* have also emerged as serious problems worldwide. *Acidovorax avenae* subsp. *avenae* has become a newly emerging problem in upland rice in Southern

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Europe. Among viral diseases caused by tospoviruses such as GBNV, WBNV, IYSV, CaCV, whitefly transmitted geminiviruses such as ToLCNDV, CLCuD.

Diseases are emerging due to some of following reasons such as (1) Development of new strains of the pathogen (2) Increase in the area of susceptible crop e.g SCLB of maize, (3) Climate variability, (4) Introduction of the pathogen to new geographical locations, (5) Introduction of more efficient pathogen vectors e.g CTV emergence in South America.

Table: Emerging infectious diseases (EIDs) caused by plant viruses

Viruses/ Diseases	Categories	Hosts	Vectors	Geographical distribution	Potential Loss
Plum pox virus	Threatening disease	*Prunus* sp.	Aphids (*Aphis fabae*)	Europe, Asia, Africa, South America	Severe
Lettuce infectious yellows virus	Emerging disease	Lettuce	Whitefly (*Bemisia tabaci*)	North America (USA)	serious
Tomato infectious yellows virus	New/ Emerging disease	Tomato	Whitefly (*Trialeurodes vaporariorum*)	North America (USA), Europe and Middle-East	
Cucurbit yellow stunting disorder virus	Threatening disease	Cucurbits	Whitefly (*Bemisia. argentifoli*)	European and Middle-East countries	Severe
Sweet potato Chlorotic stunt virus	Emerging disease	Sweet potato	Whitefly (*B. tabaci*)	Global	
Citrus tristeza virus	Emerging disease	Citrus	Aphid (*Toxoptera citricida)*	Global	Presence of *Toxoptera citricida* leads to high economic losses
Tomato spotted wilt virus	Re-emerging disease	Ornamentals/ vegetables	Thrips (*Thrips tabaci*)	Global	High
Impatiens necrotic spot virus	Emerging disease	Ornamentals	Thrips (*Frankliniella fusca*)	Global	Medium
Tomato yellow leaf curl virus	Emerging disease	Tomato	Whitefly (*B. Tabaci*)	Global	High

Emerging Plant Diseases in India

- False smut of rice (C.O. *Ustilaginoidea virens*)
- Bakanae disease of rice (C.O. *Gibberella fujikuroi/Fusarium fujikuroi)*
- Bacterial panicle blight of rice (C.O. *Burkholderia glumae*)
- Spot blotch of wheat (C.O. *Bipolaris sorokiniana*)
- Karnal bunt of wheat (C.O. *Tilletia indica*)
- Yellow rust of wheat (C.O. *Puccinia striiformis f.sp.tritici*)
- Grassy shoot of sugarcane (C.O. *Candidatus* Phytoplasma 16SrXI)
- Leaf crinkle disease of mungbean and urdbean (Complex, most probably *Leaf crinkle virus*, some believed viroid to be responsible).

How can we overcome it?

To overcome the challenges of emergence of diseases, following points can be taken into consideration:

1) Quarantine (at local, national & global level): Legal restrictions by governmental agencies to reduce the movement of plants and planting materials such as food, fiber, genetic material, horticultural species, packing materials, etc. from one region to another region.
2) By use of rapid diagnostic tool such as ELISA, PCR, RT-PCR, DNA chip, Microarray etc.
3) Marker assisted pyramiding for disease resistance gene which is effective against pathogen which rapidly develops virulence. Host Resistance (Durable/broad resistance).
4) Disease forecasting and monitoring of pathogen population
5) IDM strategies to reduce fungicide dependent management and/or focus on use of new generation fungicides
6) Botanicals and plant-derived soil amendments such as neem oil, neem cake and karanja seed extract and BCAs can be used.

CONCLUSION

Emerging diseases are those which always been present in an area but have grown in importance over the years. Re-emerging diseases are those that have been previously controlled but are once more a major problem. Emerging infectious diseases (EIDs) are those disease which are caused by the pathogens which are either discovered and/or recognized newly or their properties have changed significantly like increase in incidence, geographical or host range or change in pathogenesis or they might have evolved newly. Generally fungi, bacteria and viruses are causing the emerging diseases. Bakanae, bacterial panicle blight and false smut are emerging disease of rice and in wheat spot blotch, karnal bunt and yellow rust are emerging. Bakanae emerged particularly on basmati rice in India and false smut is observed in severe form since 2001and 2013 onwards the BPB has been alarming. Tospoviruses and geminiviruses are the two major emerging virus groups. These diseases can be effectively managed by disease forecasting and monitoring of pathogen, legal restrictions by governmental agencies to reduce the movement of plants and planting materials. We should use eco-friendly chemical for disease management.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Mushroom production: a substitute for worldwide nourishing the growing populace

Article id: 22977

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Agriculture is the backbone of Indian economy. The improvement in this sector have arrived at an esteemed level with different innovations, progressions and motorizations. This improvement is important to satisfy the nourishment demand, financial condition and in general, survival of developing population of nation with arable land assets. In this unique circumstance, mushroom farming is an appropriate option in our nation where land holding capacity is decreasing and the population is growing day by day. Mushroom is a fleshy, spore-bearing fruiting body of a fungus, normally produced over the ground on soil or on its nutrient source, for the most part in woodlands. It may be the most outstanding and archived eatable forest item (Chamberlain et al., 1998)

History of Mushroom Cultivation

Mushrooms are mysterious, cultural, traditional and legendary (Arora and Shepard, 2008) The first cultivated mushrooms were introduced in seventeenth century in Europe. In 1650, a melon producer close to Paris saw the development of some extraordinary things in his field. He chose to make it consumable and prevailing in his excitement. It was given the epithet 'Parisian mushroom'. From that point forward, a French Gardner found that cool and moist condition is reasonable for growth of mushrooms. In 1707, the primary controlled production of eatable mushroom was done in vegetable nursery. It took a long time to start the scientific investigation of Mushroom cultivation. The primary Research station was built up in 1934 at Naaldwijk-The Netherlands. Guchhi mushroom from Kashmir, India was a delicacy known to the individuals around then. The research center began by Mr. S. S. Jain (Assistant Plant Pathologist and Mycologist) at Solan, Himachal Pradesh is an architect in the mushroom development for the farmers as well as the researchers from everywhere throughout the India.

Health benefits

Mushrooms have a generally excellent health benefits with high measure of fiber, proteins and low measure of fat (Cheung, 2010). Their medicinal values include wound-healing, immunity-enhancement, and tumor-retarding effects (Chang, 1999; Dai et al., 2009). The significant supplements like vitamin B, vitamin D, potassium, copper and different cancer prevention agents are additionally present in it. A few mushrooms having high measure of cancer prevention agents are porcini, oyster, golden oyster, maitake, shiitake etc. Shiitake mushroom additionally helps in improving resistance. Mushrooms are friendly to gut of humans. They help in the sustenance of valuable microorganisms of gut like *Acidophilus* and *Bifidobacterium*. Respiratory infections, obesity, diabetes, circulatory strain etc. can be relieved by fusing mushrooms in the eating routine. The best significance of mushrooms is the presence of lectins protein which can bind to harmful cells and present it to immune system of the body for its demolition

Mushroom Production Scenario

The production of edible mushroom has been drastically increased worldwide as a result of increasing population over few decades. The production was nearly 5 lakh ton in the year 1960 and it is surprising that it has been increased over 60 lakh ton in the year 2010 (FAO, 2014). Among the leading mushroom production countries, China is leading by producing nearly 70-80 % of world mushroom production (Zhang, 2014). Button mushroom is major grown mushroom for commercial purpose followed by Shiitake and Oyster. In India, the production of edible mushroom was nearly 2000 ton in 1970 and in the year 2010, it was nearly 120000 tons. The productivity of mushroom in India is low as compared to Europe and North America. This is mainly attributed due to the use of improved strains and refinement with the growing methodologies.

Steps in mushroom production

1. **Compost preparing**

Compost for mushroom production is mainly prepared by converting the chemical nature of raw products by the activity of microbes and their respective chemical reactions. This results in a food source exclusively for the mushroom and not suited for other microbes. Composting is initiated by mixing and wetting the ingredients. Adequate moisture, oxygen, nutrients like carbon and nitrogen should be present, therefore water and supplements like corn distiller's grain, seed meals of soybeans, peanuts, gypsum etc. are added periodically and the bulk is moves with the turner.

2. **Spawning**

Spawn or seed for mushroom production is prepared by sterilizing a mixture of millets with wheat and water. Then this sterilized media is added by a bit of mycelium. The grains along with inoculum is shaken for homogeneous growth over a period of 14 days. Once the inoculum growth occurs well in the grain media, the product is ready to be known as spawn. This spawn can be stored in refrigerator for 3-4 months.

3. **Casing and pinning**

Most commonly used material for casing is sphagnum peat moss. Peat are filled in polypropylene bags of various dimensions. The spawns are placed at the outer margins of bags at different interval layer. Development of mushroom starts with rhizomorph. The development starts with very small outgrowth which needs a micro space to expand. Pinning is helpful in expanding and large growth from button stage to mushroom.

4. **Cropping and harvesting**

In the mushroom growing room, the relative humidity should be enough, which can be maintained by regular application of water (2-3 times a week). Ventilation for controlled humidity and temperature is also necessary for mushroom growing. Mushrooms can be harvested in a cycle of 7 to 10 days. This duration may vary on the temperature, humidity, cultivar, and the stage of picking.

Diseases of Mushrooms

Mushroom production is also suffered by various biotic and abiotic agents, which includes fungi, bacteria, viruses, nematodes, insects and mites. Few diseases which are more common in mushroom production are:

1. **Dactylium disease**

The disease is caused by fungus *Dactylium cladobotryum.* Cottony mycelial growth on surface of mushroom is seen which later may turn into gray or pink and mushroom develops a watery rot, which may cause loss up to 66%. Control from the disease can be achieved by good sanitation practices.

2. **Green Mould**

The most frequent and common disease in mushrooms caused due to *Trichoderma*, *Penicillium*, *Aspergillus*. *Trichoderma harzianum* is recognised as causing the most severe problems. A thick layer of mycelium of initial white and later turn to be green in color is seen on casing surface. The mushrooms in or near the mycelium turns brown and may be cracked or distorted. Sterilization of materials with good sanitization should be done. Weekly sprays of Mancozeb (0.2%) or Bavistin (0.1%) or Calcium hypochlorite (15%) give effective control of the disease.

3. **Verticillium spot**

Also known as "dry bubble" which causes the sporocarp to appear as large puffball like masses, bubbles will become covered with a fuzzy growth. The disease is caused due to *Verticillium fungicola.* For control, mix Benlate 50WP in water at 240g/ 200litres/100m² during first watering.

Table 1: Benefit Cost for one shed of Mushroom Production

Cost of shed in first year	Rs 45000
Cost of shed in second year	Rs 10000
Production cost	Rs 100000
Benefit in first year	Rs 35000
Benefit in second year	Rs 70000

Source: Directorate of Mushroom Research Chambaghat, Solan (HP)

Mushrooms could be a significant segment for our future agribusiness services. Colossal amounts of wide assortments from natural wastes are created from farming, forest services, and food industries. Mushroom cultivation is a compelling bioconversion innovation of changing squanders and woods into conceivably important assets, which could likewise be a significant piece of maintainable farming in the arena of this expanding global population.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

CLIMATE CHANGE: New Challenge for Agriculture

Article id: 22978

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INTRODUCTION

Climate change is considered as one of the major environmental problem of 21st century. Change in the concentration of $CO_{2,}$ temperature and precipitation not only affects the animals and humans but also affect the agriculture. Global agriculture production is affected less by adopting some successful irrigation facilities but the Indian agriculture is facing more challenges due to more seasonal variation. Climate change poses great threat to agriculture and food security. About 60% of the net sown area is rainfed which depend upon rainfall for their good yield. Apart from shrinking agriculture land climate change bring new challenges in feeding the ever growing population of India. Climate is a generalised weather or it is summation of weather condition over a area for a longer period of time and that time period is above 30 years. Climate change refers to any change in climate over a time which may be due to natural variability or as a result of human activity (IPCC- Intergovernmental panel on climate change). Climate change is change in climate that is attributes directly or indirectly due to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods.

Causes of climate change

Both natural and man-made causes change in the climate. In general climate changes which occurs before 1700s was due to natural causes such as change in solar energy, volcanic eruptions and natural changes in greenhouses gas (GHG) concentration and recent climate changes after mid 20th century is not only due to natural event but the human activities is the dominant one.

Natural causes:

Change in the amount of solar energy reached the earth affect the climate. Change in the shape of earth orbit as well as the tilt position, position of earth axis and change in the sun intensity affect the climate. Change in sun intensity occur from 1645 to 1715, which coincide with low temperature called little ice age because of slight cooling of N- America, Europe and other part of Northern hemisphere. Changes in the earth orbit have had big impact on climate change over hundreds of thousands of years. It affects the formation and retreat of ice sheets. Changes in solar energy affect the climate but in recent last 10 year solar cycle, solar output gets lower than mid 20 century. Similarly, change in the shape of earth orbit as the tilt and position of earth changed over hundred of year's did not changed over a last 20 years. Volcanoes have shows a noticeable role in climate. Volcanic particles reached the upper atmosphere can reflect enough sunlight back to space to cool the surface of the planet. These particles are called cooling aerosols but they remain in the atmosphere for few year and causes a slight noticeable change only.

Anthropogenic causes:

Human changes in land use and land covers have changed earth reflectivity. Deforestation, urbanisation often contributes to changes in climate but it affect is regional and very smaller when average over an entire globes.

Green house gases:

Carbon dioxide concentration has increased by an average of 1.83ppm per year over the past 40 years1979-2018. The carbon dioxide increase is accelerating which is averaged about 1.6 ppm per year in the 1980s and 1.5 ppm per years in 1990s, the growth rate increased to 2.3 ppm per year during last decade (2009-18). The annual carbon dioxide increase from January 2018 to January 2019 was 2.5±0.1 ppm.

- **Methane:**

The growth rate of methane decline from 1983 until 1999. From 1999 to 2006, methane burden was nearly constant, but since 2007 globally averaged methane has been increasing again. It was due to increase warm temperature in arctic 2007-8 and increased in precipitation in tropic in 2007-8. The global increase in methane has become even larger averaging 8.9±2.8 ppb/year through 2018.

- **Nitrous oxides:**

Concentration of nitrous oxide continue to increase slowly over time, with average rate of 1 ppb/ year over a past decade.

- **CFC (Chloro floro carbon):**

Radioactive forcing from the sum of observed CFC changes ceased increasing in about 2000 and continued to decline. This continued decline is a response to global control placed on CFC production and trade by the fully adjusted and amended montreal protocol on substances that deplete the ozone layers.

Impact of climate change on crop production:

Climate changes affect the photosynthesis rate due to change in the concentration of carbon dioxide in the atmosphere. With increase in the concentration of carbon dioxide upto 475-600 ppm, leaf photosynthesis rate increases by 40% as per the plant varieties and other environmental condition (Ainsworth and Rogers. 2007). Carbon dioxide enters the plant parts through stomatal pore but it also provides the pathway for diffusion of water out the atmosphere. Plants must regulate the stomatal opening in such a way that it increases the photosynthesis rate with less water loss. It was found that 5-20% decrease in water use under low elevated carbon dioxide concentration (Leakey *et al*. 2009). Apart from carbon dioxide, mineral obtained from soil play important role in photosynthesis. Among all nutrient nitrogen is most important, it was reported that there is less increased in photosynthesis with increase in carbon dioxide under limited supply of nitrogen (Ainsworth. 2008). Among the plant species C_3 plant shows greater increased in photosynthesis with increased in CO_2. C_4 plant donot shows much difference in photosynthesis because they have CO_2 concentrating mechanism. Legume plants capable of sowing positive response to elevated CO_2 may alter the balance between the carbon and nitrogen. In legume excess demand of nitrogen is fulfil by bacteria as plant provides excess carbon o root nodules which serve as source of energy for bacteria symbiont. Thus get benefitted by elevated CO_2 level in the atmosphere.

Impact of climate change on soils:

Global climate change cause change in soil forming process as it is a most important factor of soil formation and thus it affects the soil texture. Soil structure is important property of soil which indicates a soil health. It is strongly influenced by the amount of inorganic and organic matter present. It is responsible for maintaining balance between soil water and soil air but climate change cause a decrease in organic matter content in the soil and thus leads o decline in soil aggregates stability, nutrient retension capacity, infiltration capacity.

- **Soil temperature:**

Soil temperature affected by gain and losses of sun radiation at the surface of earth, more is the absorption more is the soil temperature. Due to increase in temperature soil temperature also increased. Warm temperature increases the rate of organic matter decomposition, microbial activity, nutrient mineralisation etc. However it is also affected by the type of vegetation occur above soil.

- **Bulk density:**

Bulk density is inversely correlated with organic matter. Decrease in organic matter content caused increased in bulk density which leads to more compacted soil and decrease in porosity.

- **Plant nutrients:**

Cation Exchange Capacity is important property of soil with respect to plant. CEC is associated with soil organic matters decrease in soil organic matter caused a decrease in Cation Exchange Capacity. Impact of climate change such as high temperature, heavy rainfall, drought affect the C cycle thus it also cause change in N,P,K and S cycle in ecosystem..

- **Biological properties:**

Soil organic matter is the most important component of soil as it influences the soil structure, water holding capacity, cation exchange capacity. It is affected by change in soil temperature, moisture and land management. Increased in soil temperature, atmospheric carbon dioxide and irregular rainfall causes decrease in soil organic matter contents. There is no direct affects of climate change on soil flora and fauna but change in vegetation and crop growing season may influence their population. Increased in carbon dioxide concentration in the atmosphere may enhanced the nitrogen fixation rates, nitrogen mobilisation and increased mycorrhizal association.

CONCLUSION:

Climate change is considered as one of the major environmental problem of 21stcentury. Response of crops to changing climate is crop-specific and also varies from region to region. Negative impact of rising temperature nullified by fertilisation affects of CO_2. It also affect the soil by accelerating the decomposition of organic matter.

Future thrust:

- Interactions effects of CO_2 and temperature on field crops need to be studies
- Germplasms to over-come climate change need to be identify.
- There is a urgent need of climate change awareness programs among the farming community.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 **Volume 2 – Issue 2 – February 2020**

Defence strategies in plants against pathogens

Article id: 22979

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INTRODUCTION

Resistance against any 'deleterious act' has become a natural and universal response of plant system. The resistance against parasites/pathogen is the heritable trait of plants by virtue of which they resist attack by parasites/pathogens or their activities. The defence mechanism(s) has ensured the survival of plants in spite of living amongst some of the potentiality devastating pathogens in addition to abiotic stresses. Plants have also developed ability to resist/tolerate various abiotic stresses. Infection depends on plant-pathogen interaction. Interaction between host and pathogens can lead to either successful infection (compatible response) or resistance (incompatible response). The molecular mechanisms involved in the perception, signalling and response in plant-pathogen interactions are major elements in the study of true resistance or susceptibility. As yet, there is no clear idea on what is really happening during certain molecular events. Nevertheless, this new insight offers us the possible answers to many questions on this topic. In this review, we deal with the basic and new hypotheses on the biochemical and molecular mechanisms that are activated in the plant during its interaction with the pathogen. To defence themselves against attack from the vast array of viruses, bacteria, fungi, parasitic plants, nematodes and insects in their environment, plants are equipped both with pre-formed, constitutive chemical and mechanical barriers as well as with inducible defence systems. Plants are normally capable of withstanding an attack by a potential pathogen and responding with a local and systemic induction of a series of defences that prevent or contain the infection and provide enhanced resistance to subsequent infections by the same or even unrelated pathogens. Recognition of a potential pathogen results in several early responses including rapid ion fluxes, activation of kinase cascades and the generation of reactive oxygen species (ROS). These early events are followed by other defence responses including induction of hypersensitive response (HR), a localized form of programmed cell death (PCD) limiting pathogen spread, further reinforcement of the cell walls, and production of antimicrobial compounds such as defence proteins and phytoalexins. Many of the plant defence responses are mediated by an interacting set of endogenous signal molecules including jasmonic acid (JA), ethylene (ET) and salicylic acid (SA). These signal molecules are part of two major pathways in defence signalling, one SA-dependent, the other SA-independent but involving JA and ET (Kunkel and Brooks, 2002). However, these are not the only endogenous signals for defence gene activation but other molecules such as ROS and nitric oxide (NO) appear also to be involved in plant defeance signaling. Plants induce multifaceted defense response against pathogens. It includes production of anti-microbial metabolites, proteins and production of callose & lignin in cell wall. SA- dependent defenses acting against biotrophs and JA- and ET- dependent responses acting against necrotrophs. The ability of plant to defend itself against pathogens depends on genetic constitution and environmental conditions.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Defense Mechanisms: Pre-existing or Passive A

Pre-existing Structural Defenses

The first line of defence in plants is present in its surface. Several characters of the plants surface function as barriers to penetration which pathogen must breach to enter the host. The pathogens enter the plant host by penetrating the epidermis along with cuticle and cuticular wax and number of natural openings existing before the onset of the pathogenesis can obstruct penetration.

If the pathogen succeeds in penetration; it encounters pre-existing internal structural barriers. The external and internal structural barriers existing before pathogen attack are also called Pre-existing defence structures or passive/static or anit-infection structures.

Wax and cuticle

The cuticle covers the epidermal cells of plants and consists of pectin layer, a cutinized layer and a wax layer. Cutin is composed of fatty acids. Waxes are mixture of long chain aliphatic compounds which prevent the retention of water on plant surface essential for spore germination. A negative charge usually develops on leaf surfaces due to fatty acids. This condition repels air-bone spore / propogules. Only few pathogens are known to dissolve cutin enzymatically. Examples: *Monilinia fructicola* penetrates cuticle of cherry leaves but not of Gingko biloba leaves; the latter contains abundant cutin than the former. *Fusarium solani* f. sp*. Pisi* produces the enzyme cutinase production by specific antibodies and inhibitors.

Epidermal layer

Epidermis is the first layer of living host cells that comes in contact with attacking microbes. The toughness of epidermis is due to the polymers of cellulose, hemicelluloses, lignin mineral substances, polymerized organic compounds, suberin etc. Potato tubers resistant to Pythium debaryanum contain higher fibre. Silicon accumulation in epidemal walls provides resistance against fungal attack. Suberization of epidermis confers protection against plant Xanthomonas axonopodis pv. Citri because of broad cuticulat lips covering the stomata. A functional defence mechanism has been observed in some varieties (cv-Hope) in which stomata open late in the day when moisture on leaf surface has dried and the infection tunes have become non fuctional.

Hydathodes are natural openings on the edges of leaves and serve to excrete excess water from the interior. They are easy entry pints of bacterial pathogens such as *X.compestris pv. compestris* (black rot of cabbage), Similar to hydathodes are the nectarthodes in inflorescence of many plants. They secrete sugary nectar and this serves as barrier to those organisms that cannot tolerate this condition and thus, can enter through nectarines. Leaf hairs on leaves and on nectarines also resist entry of pathogens. High hairlines of leaves and pods in chickpea is resistant character against *Ascpchyta rabei*. Groundnut varieties showing resistance to Cercospora leaf spots have thick epidemis-cum cuticle and compact paslisade layer, few and smaller stomata and high frequency or trochomes on the abaxial surface of leaf.

Lenticles are opening in outer walls involved in gaseous exchange. They are weak points in defence unless the cork cells within them are suberized. After suberizatoin and periderm formation, lenticels are more resistant to invasion by pathogens.

Pre-existing biochemical defence

Plants liberate different chemicals, which interfere with activities of the pathogen and pathogenesis, thereby preventing or reduce infection. These chemicals and the biochemical

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

conditions that develop may act either directly through toxic or lytic effect on the invader or indirectly through stimulating antagonistic plant surface microflora. The compounds pre-existing in plants as constitutive antibiotics and those, which are formed in response to wounds as wounds antibiotics.

Release of anti-microbial compounds

Plants while growing and developing release gases as well as organic substances, from leaves and roots (leaf and root exudates), containing sugars, amino acid, organic acids, enzymes, glycoside etc. These materials have profound effect on the nature of surrounding environment, particularly the phyllosphere, rhiizosphere microflora and fauna.

Inhibitors present in the plant cells

In many host-parasite interactions, pre-existing toxic substances in the cells form the basis of resistance. In resistant variety these substances life in abundance while in susceptible variety they may be less or completely absent. Several phenollic compounds, tannins and some fatty acid like compounds such as dienes pre-exisitg in high concentrations in cells have been implicated for the resistance or young tissues to parasitic fungi such as Botrytis. Many such compounds are potent inhibitors of many hydrolytic enzymes. Several other types of preformed compounds such as saponins (glycosylaled steroidal or triterpenoid compound) tomatine in tomato and avenacin in oats have antifungal membranolytic activity. The fungal pathogens which lack enzymes (saponinases) that breakdown the saponins are prevented from infecting the host. Several preformed plant proteins have been reported to act as inhibitors of pathogen proteinases or of hydrolytic enzymes. Similarly lactins (proteins that bind to certain sugars) cause lyses and growth inhibition of many fungi. Plants surface cells also contain variable amounts of hydrolytic enzyymes such as glucanases and chitinases, which may cause breakdown of pathogen cell wall components.

Lack of essential factors

Recognition factors

The first step in infection process is the cell-to-cell communication between host and pathogens. Plants of species or varieties may not be infected by pathogen if their surface cells lack specific recognition factors. If the pathogen does not recognize the plant as one of its hosts it may not adhere to the host surface or it may not produce infection substances such as enzymes, or structures (appresoria, haustoria). These recognition molecules are of various types of oligosaccharides and polysaccharides and glycoproteins. Host receptors and sites for toxins

In many host parasite interactions the pathogen produces host specific toxins, which are responsible for symptoms and disease development. The molecules of toxin are supposed to attach to specific sensitive sites or receptors in the cell. Only the plants that have such sensitive sites become diseased

Essential nutrients and growth factors

The fact that many facultative saprophytes and most of the obligate parasites are host specific and sometimes are so specialized that they can grow and reproduce only on certain varieties of those species suggests that for these pathogens the essential nutrients and growth factors are available only in these hosts. Absence of these nutrients and stimulus make the other varieties and species unsuitable hosts.

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Defence mechanism: Induced or active

Plants have to face the wide variety of pathogens (enemies) standing at a place. Thus a strategically designed pre-existing (structural and biochemical) defence mechanism in plants exists. The real value of this system has not been critically examined. It appears that these pre-existing defence mechanisms help plants in warding-off most of microbes as nonpathogens. But it does not seems t be sufficient.

The induced/active defence mechanism in plants may operate at different levels

1. Biochemical defence
2. Defence at cellular level
3. Defences at tissue level

The activation or induction of defence mechanism may be both specific and non-specific type. Several structural changes are known to be induced by a range of biotic or abiotic elicitors. These dynamic defence mechanisms prevent further colonization or spread of pathogen. Active defence in plants involves cellular defences that rely upon preformed surveillance systems are encoded by resistance genes. The receptor-proteins are strategically located in cell membrane to detect the pathogen or factor translocated by pathogens. The ability of plant to mount an active defence response is again under genomic control.

1. Disease occurs when Pre-exisiting defence mechanism are not enough to check the entry of pathogen
2. A pathogen avoids timely eliciting active defence system in plant tissue or habits active defence response by secreting metabolic toxins.

Induced structural defence

Even after the establishment of infection in plant cells, the host defence system tries to create barriers for further colonization of tissues. This may be at various levels.

Lignifications

Lignified cell wall provide effective barrier to hyphal penetration. They also act as impermeable barrier for free movement of nutrient causing starvation of pathogen.

Following are examples.

Radish: *Peronospora parasitica, Alternaria japonica*

Potato: *Phytophtora infestans*

Wheat: *Septoria nodorum*

Cucumber: *Cladosporium cucumerium, Colletorichum lagenarium Carrot*: *Botrytis cineria*

Suberization

In several plants the infected cells are surrounded by suberized cells. Thus, isolating them from healthy tissue. Corky layer formation is a part of natural healing system of plants. eg. Common scab of potato and rot of sweet potato are good examples.

Abscission layers

It is a gap between host cell layers and devices for dropping –off older leaves and mature fruits. Plant may use this for defence mechanism also. I.e. To drop-off infected or invaded plant tissue or parts, along with pathogen. Shot holes in leaves of fruit trees is a common feature

Tyloses

The tyloses are formed by protrusion of xylem parachymatous cell walls, through pits,

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into xylem vessels. The size and number of tyloses physically block the vessel. The tyloses are inductively formed much ahead of infection, thus blocking the spread of pathogen. It suggests biochemical elicitors and movement of tyloses inducing facto (TIF) up the stem. eg. Sweet potato: *Fusarium oxysporum f. sp. Batatas.*

Gum deposition

The gums and vascular gels quickly accumulate and fill the intercellular spacis or within the cell surroundings the infection thread and haustoria, which may starve or die.

Mechanism of host resistance

The cellular defence structures, ie. Changes in cell walls, have only a limited role in defence. Following types are commonly observed.

1. Carbohydrate apposition (synthesis of secondary wall and papillae formation)
2. Callose deposition (hyphal sheathing just outside plasma lemma around the haustorium which delays contact of pathogen (*Phytophythora infestans*) with host cells.
3. Structural proteins
4. Induced cytoplasmic defence that present last line of host defence and may effective against slow growing pathogens, weak parasites or some symbiotic relationship.

Induced biochemical changes

The induced biochemical changes in host plants are the last line of host defence. This may condition a plant or plant tissue from susceptible to resistant to immune status as per their genetic potential. The role of bio chemical factor in host defence is based on the following four attributes:

- The substance is associated with protection against disease at the site where protection occurs.
- The substance can be isolated from the host showing protection against the disease.
- Introduction of isolated substance to the appropriate susceptible host confers protection.
- The nature of protection so induced resembles that of the natural agents of a resistant plant.

Toxic substances produced

Rapid production/suitable modifications and/or/ accumulation of chemicals toxic to pathogen upto effective concentrations is an important component of overall active defence strategy of plants. Slow production or accumulation or low levels of similar chemicals have reported in susceptible host plants also.

Role of phenolic compounds

The phenolic compounds, viz. chlorogenic acid, caffeic acid and oxidation products of floretin, hydroquinone hydroxyl quionones and phytoalexins are main toxi chemical produced to inhibit pathogen or its activities. Some of these are performed toxic chemicals while others may be de novo synthesized or modified to more toxic forms. The enzymes involved in chemical pathways are present in host cell (pre-existing).

Role of phytoalexins

Most common response of plants to stress, biotic (phytoalexins/insects) or abiotic (wounding), is the production and accumulation of substrates that can inhibit the growth and

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activities of the biotic factors or may help in healing process. Muller and Borger proposed the concept of phytoalexins in their study on hypersensitive reaction of potato to avirulent *Phytophthora infestans* strains. Phytoalexins are antibiotics produced in plant pathogens interactions or as result reposnse to injury or other psychological simulation.

Role of new protein synthesized

Post-infectional changes in host cells involve production and modification of large number of proteins (structural and enzymatic), which have important role in defence mechanism. The enzymes are required for various synthetic pathways (normal or modified) for production of resistance related substances. In addition, phenol-oxidizing enzymes have vital role. The influence of these changes may be confined to infection site or nearby cells. Increased synthesis and activity of phenyl ammonia lyase (PAL) has been reported in several bacterial and vital pathogens in resistant reaction. PAL plays key role in syntheses of phenols, phytoalexins and lignin. The effectiveness of resistance depends on speed and amount of synthesized products and their movements to neighboring healthy tissues to create defensive barriers.

Inactivation of enzymes and toxins

The role played by chemical weapons (toxin and enzymes) of pathogens during pathogenesis is well established. The necrotrophs and hemihiotrophs employ more of these substances fro causing those tissue damage as compared to specialized obligate parasites. The defence strategy of resistant plants, through activity of phenols, tannins and protein as enzymes inhibitors, the phenolics are not anti-fungal but make pathogen ineffective by neutralizing their enzymes. In immature grape fruits catechol-tannin is known to inhibit enzymes produced by Botrytis cinerea.

Role of altered biosynthetic pathway

The pose inflectional metabolism of host tissue is altered (stress physiology) to cope with the advancing activities of pathogen. New enzymes (proteins) are produced in an effort to synthesize defence related substances. Most of these compounds are formed through Shikmic acid pathway and modified acetate pathway. Respiration in diseased tissue is invariably increased; a part of glycolysis is replaced by pentose pathway, which yields four carbon compounds are formed through Shikmic acid pathway and modified acetate pathway. Respiration in diseased tissue is invariably increased; a part of glycolysis is replaced by pentose pathway, which yields four carbon compounds. It is possible that in early stages of infection the gene regulation of host cell is influenced and some specific genes.

Active defense to pathogens

Induction of host resistance, structural or biochemical seems to be universal I plants. Active defense responses have been reported against all classes of pathogens (fungi, bacteria, viruses and nematodes). Active defense response may lead to incompatible host-pathogen interaction

Summary of induced biochemical defense reactions

1. On entry of the pathogen, a temporary increase in cellular metabolic activities occurs in the host. Due to stress caused by increased metabolic activity cells die rapidly showing hypersensitive reaction. Rapid death of cells in correlated with increased degree of resistance

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in most diseased systems.

2. When the infected tissue are reaching the nectotic stage, metabolism of neighboring tissues is also increased and phenolics and other compounds are accumulated. In this process, the synthesized compounds move from healthy to diseased tissues.

3. The reactions expressed by hypersensitivity form common phenols, phytoalexins, and other abnormal substances. The oxidized products of phenolics may detoxify the toxins or inactivate other weapons of the pathogen.

4. When spread of the pathogen is checked, the neighboring healthy tissues with accelerated metabolic activities try to isolate the damaged parts by forming new tissues and eliminate the disease/pathogen.

Host defence, pre-existing or induced, is a multi-component strategy where several factors work together to fashion the final outcome. Figure below represents a case where more than on factors are responsible to condition resistance in immature grapes berries against Botrytis cinerea.

Multi component defense mechanism in young grapevine berries against *Botrytis cincerea*

Systemic acquired resistance

Induced resistance (cross protection) in plants is a phenomenon of significance, which has not been properly exploited for plant disease management, probably because of our poor understanding. Induced resistance,, localized or systemic, may be specific. The signal molecule, that propagates the resistance to distant places are vital in systemic induced resistance. The resistance is induced in manner comparable to immunization in mammals but the mechanism differs.

The resistance may be induced due to any of the following:

1. Accumulation of PR proteins
2. Activation of lignin synthesis
3. Enhanced peroxidase actitivity
4. Suitable changes in plant metabolism

Principle of induced resistance

Induced resistance is a phenomena where a lead treated with certain chemicals or inoculated with pathogen's avirulent strain produce a signal compounds that is transported systemically throughout the plant and activities its defence mechanism (making the entire plant resistant to subsequent infection) without its own physical presence at the site. The picture below explains a hypothetical mode to explain induction of SAR.

Representation of acquired resistance a) Local b) Systemic c) SAR

Biochemical Defence Mechanism

Phytoalexins: Concept given by Borger & Muller (1940) in Potato late blight interactions. Defined as antibiotics produced in plant- pathogen interaction or as a response to injury or physiological stimuli (Kuc, 1972).

Paxton (1981): Defined phytoalexins as low molecular weight antimicrobial compounds which are synthesized by and accumulates in plant cells after microbial infection. Involves the role of elicitors in their production. Not produced during biotrophic infection.

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Phytoalexins have been isolated from plants (>20). Families: – E.g. leguminosae, solanaceae, malvaceae, graminae, compositae, umbelliferae, chenopodiaceae.

Characteristics of phytoalexins:

1. Fungistatic & bacteriastatic and active at very low concentration.
2. Produced by the host in response to infection or metabolic by-products of micro-organisms and stimuli.
3. Absent in healthy cells or present in very minute quantity.
4. Produced in large quantity in response to weak pathogen or non pathogen than virulent one.
5. Produced relatively quickly in cells after infection.
6. Host specific rather than pathogen specific.

Hypersensitive response:

The term Hypersensitivity was first used by Stakman (1915) in wheat infected by rust fungus. Result in sudden death of the host cells in the vicinity of the pathogen.

Highest degree of resistance. Both structural and biochemical in nature. Common in obligate pathogens like fungi, viruses and nematodes, also found in other fungal & bacterial infection.

Due to Hypersensitive response

1. The most common new cell functions and compounds include:
2. A rapid burst of oxidative reactions.
3. Increased ion movement, effective of K and H through cell membrane.
4. Production of antimicrobial substances such as phytoalexins and pathogenesis-related proteins (such as chitinases).

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e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

General principles of plant disease management

Article id: 22980

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INTRODUCTION

Information on etiology, symptoms, pathogenesis and epidemiology of plant diseases are intellectually interesting and scientifically justified but most important of all they are useful as they help in formulation of methods developed for successful management of disease and thereby increasing the quantity and improving the quality of plant and plant products. Practices of disease management vary considerably from one disease to another depending upon the type of pathogen, the host and the biotic and abiotic factors involved. Contrary to management of human and animal diseases where every individual is attended, the plants are generally treated as populations and measures used as preventive rather than curative. Methods for plant diseases control were first classified by Whetzel (1929) into exclusion, eradication, protection and immunization. Further advances in plant pathology leading to development of newer methods. Two more principles - avoidance and therapy were created (NAS, 1968)

Avoidance

It involves avoiding disease by planting at time when, or in areas where inoculums is absent or ineffective due to environmental conditions. The major aim is to enable the host to avoid contact with the pathogen or to ensure that the susceptible stage of the plant does not coincide with favourable conditions for the pathogen. The main practices under avoidance are choice of geographical area, selection of the field, choice of sowing/ planting time, selection of seed and planting material, short duration / disease escaping varieties and modification of agronomic/cultural practices. The potato cultivation at high altitude is relatively free from viruses; as prevailing environmental conditions do not permit the buildup of vector populations. Similarly, early planting of potato or wheat, in indo Gangetic plains may escape late blight or stem rust damage respectively.

Exclusion

It means preventing the inoculums from entering or establishing in a field or area where it does not exist. Seed certification, crop inspection, eradication of inoculums and / or insect vectors, and quarantine measures are some of the means of preventing the spread for pathogens.

Eradication

The process of reducing, inactivating, eliminating or destroying inoculums at the source, either from a region or from an individual plant in which it is already established is termed as eradication. Eradication involves eliminating the pathogen from infested areas; the magnitude of the operation involved may vary considerably. On eof the most extensive eradication operations carried out so far was to get rid of the citrus canker (xanthomonas axonopodis)in the USA during 1927- 35. As many as 4 million citrus trees were cut and burnt at a cost of about 2.5 million dollars to eradicate the pathogen. The practices invariably employed to achieve eradication of inoculums include eradication of alternate and / or collateral hosts, crop

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

rotations, field sanitations, heat or chemical treatments of plant materials or soil, biological control etc.

Protection

The protection of infection courts against the inoculums of many fast spreading infectious pathogen, brought by wind from neighboring fields or any other distant place of survival. Principles of avoidance, exclusion and eradication may not be sufficient to prevent the contact of host with pathogen, thus development of the disease is imminent. Measures are necessary to protect host plants from invading inoculums. It can be achieved by creating toxic barrier between the plant surface and the inoculums. Methods employed to achieve such results are chemical sprays, dusts, modification of environment, and modification of host nutrition.

Host resistance

It utilizes in – built mechanism to resist various activities of pathogen. The infection or subsequent damage by pathogen can be rendered ineffective through genetic manipulation or by chemotherapy. The host resistance can also be induced by use of certain biotic and abiotic factors. The discovery of Mendelian laws of inheritance and developments in plant breeding techniques have helped in developing crop varieties resistant to specific pathogen or group pf pathogens. The classical breeding techniques include selection, mutation and hybridization. Use of biotechnological tools such as tissue culture, genetic engineering and protoplast fusion are being used to develop resistant cultivars of various economically important crops.

Therapy

It is the treatment of infected host plant, which is attempted in case of economically important horticulture plants. As a principle of plant disease control, it provides an opportunity to cure or rejuvenate the diseased host plant by use of physical or chemical agents. The first five of

these principles are mainly preventive (prophylactic) and constitute the major components of plant disease management. They are applied to the population of plants before infection takes place. Therapy is a curative procedure and is applied to individuals after infection has taken place.

Under the concept of disease management these principles have been classified into following five categories:

1. Management of physical environment (cultural control)
2. Management of associated micro biota (biological antagonism)
3. Management of host genes (host resistance)
4. Management with chemicals (Chemical control)
5. Management with therapy (Physical, chemical etc)

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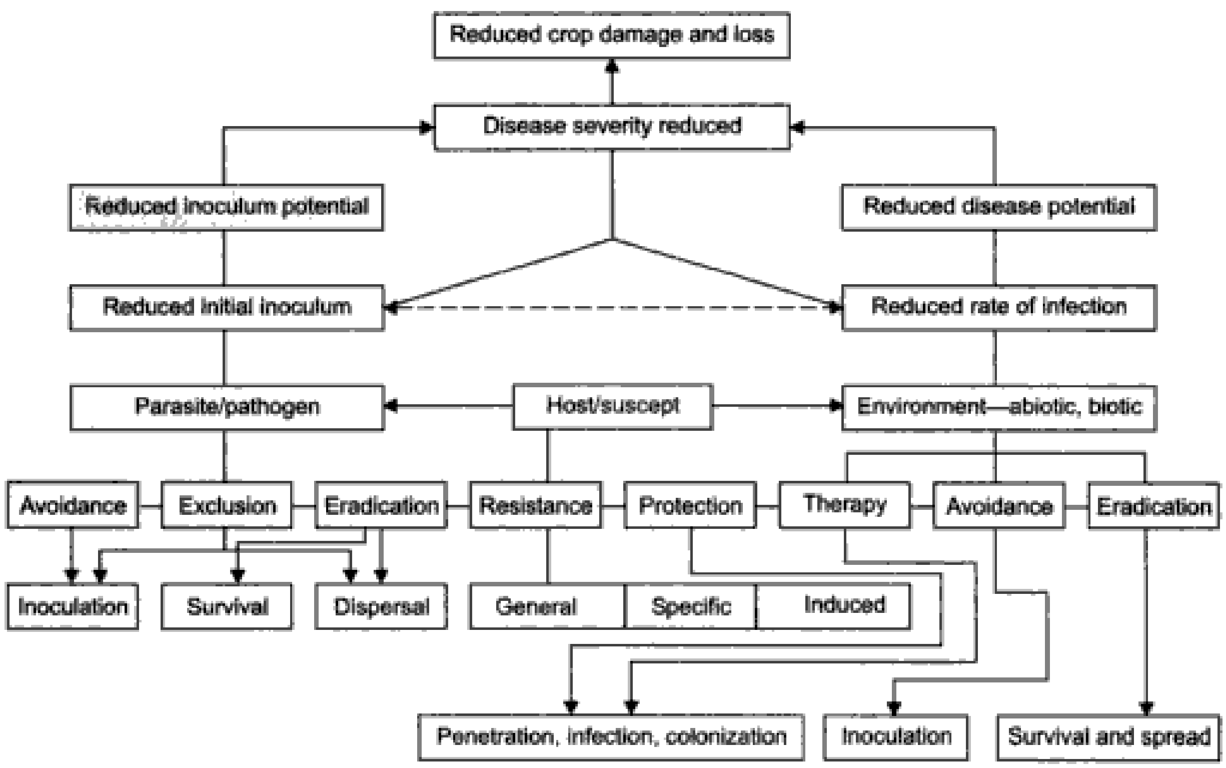
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

The six principles that characterize the modern concept of plant disease management should be viewed from three stand points
(a) Reduction in the initial inoculums or the rate of disease development.
(b) Management of the pathogen population, the cure or induce defense of the suscept or modify the environment as it influences disease and
(c) Interruption of dispersal, survival or the course of disease development.
These interactions are originally proposed by Baker (1968) and Roberts and Boothroyd (1972) and subsequently modified for the readers are illustrated as below:



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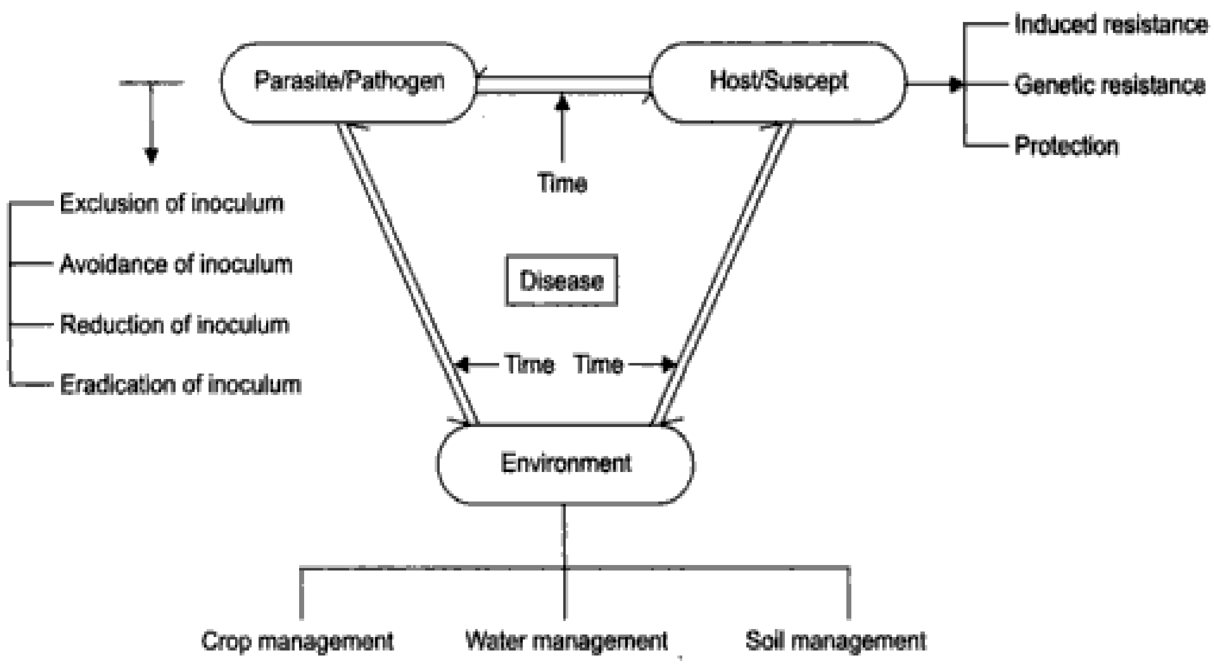
Integrated disease management

The term Integrated pest management was originally designed for management of insect pest but it is equally applicable to plant diseases also. IPM is an ecosystem- based strategy that focuses on long term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, and modification of cultural practices and use of resistant varieties.

Management of pathogen involves the practices directed to exclude, reduce or eradicate inoculums. Management of the host involves the practices directed to improve plant vigor and induce resistance through nutrition, introduction of genetic resistance through breeding and providing need based protection by chemical means. Management of environment involves the practices that modify the environment which is not favorable to pathogen or disease development and does not predispose host to attack.



CONCLUSION

As far as principles are concerned out of six, five principles comes under protective action whereas only one i.e. therapy comes under curative action. When we are planning management practices for a plant disease, we should include these principles in this way, so that we can manage the disease effectively.

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www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 **Volume 2 – Issue 2 – February 2020**

Management of insect vector borne viral diseases

Article id: 22981

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INTRODUCTION

Insects are efficient vectors for pathogens that cause various types of diseases. The prevalence and transmission of diseases depends upon the attributes and requirements of at least three organisms: the pathogen, the insect vector and the host. The prevention and control of vector borne diseases in the early 20th century was achieved through the efficient control of vector populations. The ability to genetically modify insects opens the door to novel techniques for the control of vector populations Here we review the recent advances in insect transformation techniques and various strategies for the genetic control of vector borne diseases and insect population suppression, with emphasis on mosquito vectors. These approaches are also applicable to other disease vectors as well as insects of agricultural importance.

Epidemiology of vectored plant pathogens involves the plant, the pathogens, the vectors, and the environment, all interacting in various ways. Often, an understanding is needed of seasonal cycles of host plants, pathogens, and vectors. For example, pathogens and vectors important to an annual crop may have non-crop reservoirs between harvest and re-planting. Vectors may overwinter in the crop, or on alternate host plants. The host range of the pathogen may determine whether inoculum control is feasible or not. Some pathogens are transmitted via plant propagation, and others are not. The epidemiology of vectored plant pathogens often is complex and an integrated approach to management is needed. Often, no single approach will achieve adequate control. This section is organized according to the concept of integrated pest management, including chemical control, biological control, host plant resistance, cultural control, and regulatory measures. Each of these categories will be considered in terms of the vectors and the pathogens.

CHEMICAL CONTROL

Chemical control of vectors will limit spread of vectored plant pathogens if two conditions are met. First, the vector being controlled must be a colonizer of the crop being treated. Some plant viruses are transmitted by transient flying insects. In these cases, chemical control has a poor record. Second, most of the spread must come from within the treated area (secondary spread). For the most part, insecticides simply prevent the buildup of populations of insects within a treated area. Most pesticides will not kill an immigrant insect before it has a chance to transmit a pathogen. Thus, if there is an infected field nearby with a high population

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

of vectors, pesticide treatment may not be very effective in preventing infection from primary spread. Pesticide treatment has a good track record for control of certain luteovirus diseases such as potato leafroll and barley yellow dwarf, spread by colonizing aphids. Even if the above conditions are met, dependence on chemical control of vectored pathogens in perennial crops may be risky, because a single missed spray application or insecticide failure could result in infection and demise of the crop. Another variation on chemical control is the use of stylet oil. Certain horticultural oils can reduce transmission of viruses by aphids. This methodology can reduce transmission of pathogens carried by transient insects, something that is not usually possible with standard insecticides. There is also potential for use of insect repellents for vector management. Some work has been done with visual repellents (mulches, paints, colored netting), but little has been done with chemical repellents. There is no known chemical control of plant viruses, but some fastidious bacteria in perennial tree crops can be controlled with injected antibiotics. Remission of symptoms usually is temporary.

BIOLOGICAL CONTROL

The use of biological control for management of vectored pathogens has a mixed review. Obviously, fewer vectors is better; however, sometimes the economic threshold for vectors is so low that it is not achievable through biological control. Sometimes, the presence of natural enemies evokes scatter responses in vector prey. This can actually cause an increase in pathogen transmission. Total dependence on biological control for a vectored pathogen in a perennial crop is risky. Biological control inherently fluctuates between high populations of pests and high populations of natural enemies. If pests are not vectors, the crop often can stand temporary high pest populations, but if the main concern is pathogen transmission, the entire crop can be lost if populations fluctuate in favor of the pest. Similarly, often a grower will have to spray for another pest. The pesticide may kill the natural enemies of the vector, resulting in an increase in transmission of the pathogen and destruction of the crop. Biological control in simpler island ecosystems may have a better chance to work than in more complex settings. For example, the introduction of psyllid parasitoids into R union Island dramatically reduced the transmission of the bacteria that cause citrus greening disease. However, the same parasitoids are present in Viet Nam, and citrus greening disease is a major limiting factor in citrus production there. Sometimes disruption of existing biological control can result in an increase in transmission of a plant pathogen. Increased spraying for late blight (caused by a fungus) in potatoes was linked to a major increase in numbers of green peach aphids. Evidently, populations had been controlled by an aphid pathogenic fungus that was killed by the fungicide applications for late blight. The result was a big increase in incidence of potato leafroll virus (PLRV), transmitted by the aphids. Biological control of the pathogen is another option. Usually this is done by means of cross protection - infecting a crop with a mild strain of a pathogen that prevents symptom expression of a more severe strain that may be transmitted by an insect later on. Cross protection has worked very well for control of citrus tristeza virus, an aphid transmitted closterovirus, in several parts of the world.

HOST PLANT RESISTANCE

The efficacy of plant resistance to vector depends on the means of resistance and the mode of transmission. Resistance that prevents feeding or repels the insects can prevent transmission of pathogens spread by feeding. If the resistance merely prevents or slows population growth, it cannot prevent primary spread. It can, however, have some effect on secondary spread. Resistance to the pathogen probably is the most effective means of controlling vectored plant pathogens. If plant resistance to the pathogen is available, it should be the first line of defense. Complications with host plant resistance can occur if the pathogen evolves strains that can break down the resistance. Also, some crops are notoriously difficult to breed due to difficult genetics or longevity. Resistance to the pathogen may be the only means of management in some cases. An example is sugarcane mosaic virus. Sugar cane is propagated vegetatively, so the virus is propagated with the crop. Once planted, a crop remains in the same field for several years of production, and planting is staggered throughout the production area. Thus, even if clean planting stock could be found, there is no possibility for an area-wide crop-free (and virus-free) period. The virus is transmitted by transient winged aphids, including species that do not necessarily colonize the sugar cane crop, so pesticide application is not effective. Fortunately, there has been success with mosaic resistant cultivars.

CULTURAL CONTROL

Many of the effective management practices for diseases caused by vectored plant pathogens involve some sort of cultural control such as adjusted planting date, pruning, roughing, and removal of volunteer crop plants and other non-crop reservoir hosts of vectors or pathogens. Adjusting planting dates can minimize crop exposure to vectored pathogens. In the Pacific Northwest, several vectored pathogens, transmitted by eriophyid mites and aphids, can damage early-planted fall cereals. The mite transmitted viruses are particularly serious because they cause severe yield loss, resulting in total crop failure in some cases. These viruses infect newly seeded winter wheat that is planted near a maturing crop from the previous season, or near infected volunteer grain. These viruses are most troublesome in years when the old crop is slow to mature, and there is overlap between late-maturing cereal crops from the previous season and emergence of newly sown winter wheat. The infective mites are blown from the old crop to the new one. After landing on the new crop, they apparently stay put, because there is little secondary spread in the fall. The mites cannot survive very long off a host plant, so any break in the “green bridge” between old and new crops will prevent infection. As little as 10 days delay in planting can make the difference between crop failure and negligible incidence. Similarly, the aphid transmitted barley yellow dwarf virus complex largely can be prevented by delay in planting. Other viruses are managed on an area-wide basis by maintaining a crop-free period at some time during the year. For such a policy to work, all growers in the area must cooperate in field clean-up and coordination of planting dates. Pruning and roguing often are used as a means of management of vectored plant pathogens, especially in perennial crops. The efficacy depends on whether latent infections remain, and if so, whether plants with latent

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infections are suitable source plants for vectors. In the early stages of an epidemic, there usually will be more plants with latent infections than with visible symptoms. If plants with latent infections can serve as source plants for vectors to acquire the pathogens, and vectors are present, pruning and roughing will not be very effective. In some cases, pruning actually can eliminate disease. Pierce's disease of grape vines is caused by a xylem limited bacteria called *Xylella fastidiosa*. It moves slowly in the plants. If Pierce's disease is transmitted by small leafhoppers that feed on twigs, winter pruning can eliminate most of the infection. However, if the disease is transmitted by the much larger glassy winged sharpshooter (*Homalodisca coagulata*), which feeds on larger branches and trunks, pruning is much less effective. Control of volunteer crop plants may limit or eliminate primary inoculum for newly planted crops. Volunteer potatoes are important sources of virus inoculum in Idaho potato seed production areas. Similarly, volunteer grain can be an important reservoir for aphids and barley yellow dwarf at planting time for winter wheat. The volunteer wheat provides a "green bridge" for the viruses and their vectors between harvest of one crop and emergence of the next one. Other cultural control measures include elimination of weed hosts of vectors or pathogens, use of reflective mulches and paints to repel vectors, and various protective row covers. Quite a bit of work also has been done on the use of windbreaks and barrier crops to protect susceptible plantings.

REGULATORY MEASURES

Regulatory measures for control of vectored plant pathogens are a very important aspect of management, especially for those pathogens that are transmitted through propagation. Strict sanitation measures for propagative material are common. Other kinds of regulatory measures include crop-free periods, quarantines, and required virus testing. One of the best ways to prevent vector-borne disease in plants is to keep the disease and the vector out. Many plant diseases and vectors that occur elsewhere in the world do not occur in the United States. Some of these are listed as quarantine or actionable pests/ diseases. If they are found at U.S. ports of entry, the shipment is rejected. If a pest or disease has a limited distribution in the U.S., there may be a state quarantine for certain items. For example, if a pest is found in Florida but not in California, California may reject shipments from Florida that contain the pest. Production of healthy propagation materials involves regulatory agreements. Potato tubers grown for seed are subject to winter testing for a variety of vector-borne viruses. Standards are much stricter for early generation seed. Citrus trees are propagated vegetatively by grafting, in order to ensure varietal uniformity. Citrus trees used for budwood in Florida are required to be tested for citrus tristeza virus every year. Those found to contain severe strains are no longer allowed to be used for propagation purposes. Lettuce mosaic virus and bean common mosaic virus are transmitted by seed as well as by aphid vectors. Some states have regulations in place requiring that seed used commercially in the state be tested and meet standards for virus incidence. In warm climates where crops are grown year around, control of diseases caused by vectored pathogens can be particularly challenging. Sometimes an agreement is made to adhere to a cropfree period to break the disease cycle. State regulatory agencies may be involved to ensure that there are consequences for any growers that do not comply. Other regulations are tailor-made for a given situation. Green peach aphids (*Myzus* *persicae* (Sulzer)) transmit potato leafroll virus (PLRV), which causes an important disease in potatoes. The aphids overwinter in peach and apricot trees. In the spring, they leave the trees and infest potatoes and other plants. In parts of Idaho where seed potatoes are grown, it is illegal to grow peach and apricot trees. If the trees are found, the state can require their removal. Guy Bishop, University of Idaho, discovered that another source of green peach aphids was greenhouse grown bedding plants. These infested seedlings were purchased by home gardeners, who often also grew potatoes. Frequently, the home grown potatoes either were grown from seed saved from previous years, or from unregistered seed. Thus, the PLRV infection rate in home gardens was high. Bishop found that the closer a seed potato field was to a town with home gardens, the more likely it was that the seed farmer had unacceptably high levels of PLRV. Regulations were made to prevent sale of infested bedding plants. Additionally, the local growers provided home gardeners with clean potato seed tubers. Incidence of PLRV in seed potatoes decreased dramatically in the region after the regulations were implemented.

INTEGRATED MANAGEMENT

Most often control of vectored pathogens of plants will involve an integrated approach. A good example is potato production. Some popular varieties of potatoes develop internal discoloration as a result of infection with PLRV that results in rejection by potato processors. In order to prevent PLRV infection there are regulatory measures to ensure clean propagation material. Additionally, commercial ware potato growers employ scouts to survey for green peach aphids. If numbers reach an economic threshold the crop is treated with insecticide to prevent secondary spread of PLRV. Cultural controls include removal of volunteer potatoes, and in some cases, removal of peach and apricot trees that are overwintering sites for vectors. Department of Agriculture inspectors make the rounds of retail vendors of bedding plants, preventing sale of infested ones. Finally, there is work at the federal and state levels to breed potato varieties that are more tolerant to PLRV infection, but that also retain the taste, baking and processing qualities of the popular susceptible cultivars. Epidemiology of vectored pathogens affecting crops is a complex and very interesting field of study. Many more puzzles remain to be solved that will make even more effective management a possibility.

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 **Volume 2 – Issue 2 – February 2020**

Tips for Integrated Management of root-knot nematode in Garlic (*Allium sativum*)

Article id: 22982

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Garlic (*Allium sativum* L.) is an important spice crop cultivated all over the country during *Rabi* season. The total production of garlic is about 14.25 lakh metric tons from an area of approximately 2.62 lakh hectares in India. Rajasthan, Madhya Pradesh, Uttar Pradesh, Gujarat, and Punjab are the major garlic growing states producing more than 88 % of garlic in the country. Garlic suffers from various fungal, bacterial as well as viral diseases causing considerable yield loss in different cultivated areas in the country. Root-knot nematode (*Meloidogyne* spp.) is one of the most damaging genera among the plant-parasitic nematodes on vegetables and other horticultural crops. Root-knot nematode is also called as hidden enemy of crops. The genus includes more than 90 species with some species having several races. More than 2000 plants worldwide are susceptible to infection by root-knot nematodes. The root-knot nematode (*Meloidogyne graminicola*) in garlic was reported for the first time in 2015 from Karnataka followed by Karnal (Haryana) in 2016. It is evident now that the root-knot nematode is emerging as a new constraint in quality production of garlic in India. The quality production of garlic can be achieved by approaching integrated disease management of root-knot nematode through integration of cultural practices viz. intercropping, soil amendment through neem cake, bio-pesticides and application of nematicide. The symptoms of infestation on roots and leaves and tips for integrated management practices of root-knot nematode (*Meloidogyne graminicola*) in garlic are described hereunder.

Symptoms on roots

Root-knot nematodes usually cause swellings on the roots called galls or root-knots which are the result of second stage juveniles infestation (Plate 1 A & B). The formation of these galls damage the water and nutrient uptake system of roots. The nematode infested roots in garlic also allow the entry of soil-borne pathogenic fungi viz., *Fusarium oxysporum* and *Phoma terestris*.

Symptoms on leaves:

The yellowing of leaves and drying of plants are the true symptoms of root-knot nematode infestation in garlic (Plate 1 A). Infected garlic plants on uprooting showed numerous typical root galls or root-knots. The number of root galls (small, medium and big size) may rang from 3 to 12 per plant at early stage. These may be of oval, round and cylindrical in shape. The typical symptoms of nematode galls are that they are mostly formed in root tips of garlic plants.

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

Tips for integrated management of root-knot nematodes

The quality production of garlic can be achieved by integrating the cultural practices, intercropping, soil amendment through neem cake, biopesticides and use of chemical nematicide etc. The most reliable integrated management practices can prove to be preventive to reducing infestations of root-knot nematode in soil. The tips are described below:

- **Summer deep ploughing** of field during May and June can reduce root- knot nematode population in soil.
- **Soil solarization** can be used to temporarily reduce the nematode populations in the top 15 cm of soil.
- **Soil amendment** with neem cake @ 5.0 q/ha one month before planting can play an important role to suppress the nematode population by anti-nematiciadal activity and reduce the movement and feeding capacity of juveniles.
- **Intercropping** with marigold may help in reducing the root knot nematodes in soil. French marigold varieties viz Nemagold, Petite Blanc, Queen Sophia, and Tangerine have been found most effective.
- **Bio-pesticide** Application in soil namely *Trichoderma viride* @ 5 kg/ha before one week of planting effectively minimizes the root-knot nematode.
- **Application bio-pesticide** viz., *Paecilomyces lilacinus* @ 5 kg/ha (a potential egg parasite) effectively controls of the root-knot nematode population.
- **Nematicide** viz. carbofuran application @ 25 kg/ha alongwith fertilizers before planting of garlic effectively controls the root-knot nematode. Thus, quality production of garlic can be obtained by approaching the integrated management practices.

A. Root-knot nematode affected plants of garlic

B. Close-up of root-knot nematode galls at the root tips of garlic

AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

CRISPR-Cas: A New Genome Editing Tool

Article id: 22983

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Introduction: What is genome editing?

- Genome editing, or genome engineering, or gene editing, is a type of genetic engineering in which DNA is inserted, deleted, modified or replaced in the genome of a living organism. Unlike early genetic engineering techniques that randomly inserts genetic material into a host genome, genome editing targets the insertions to site specific locations.
- In 2018, the common methods for such editing used engineered nucleases, or "molecular scissors". These nucleases create site-specific double-strand breaks (DSBs) at desired locations in the genome. The induced double-strand breaks are repaired through nonhomologous end-joining (NHEJ) or homologous recombination (HR), resulting in targeted mutations ('edits').
- As of 2015 four families of engineered nucleases were used: meganucleases, zinc finger nucleases (ZFNs), transcription activator-like effector-based nucleases (TALEN), and the clustered regularly interspaced short palindromic repeats (CRISPR/Cas9) system. Nine genome editors were available as of 2017.

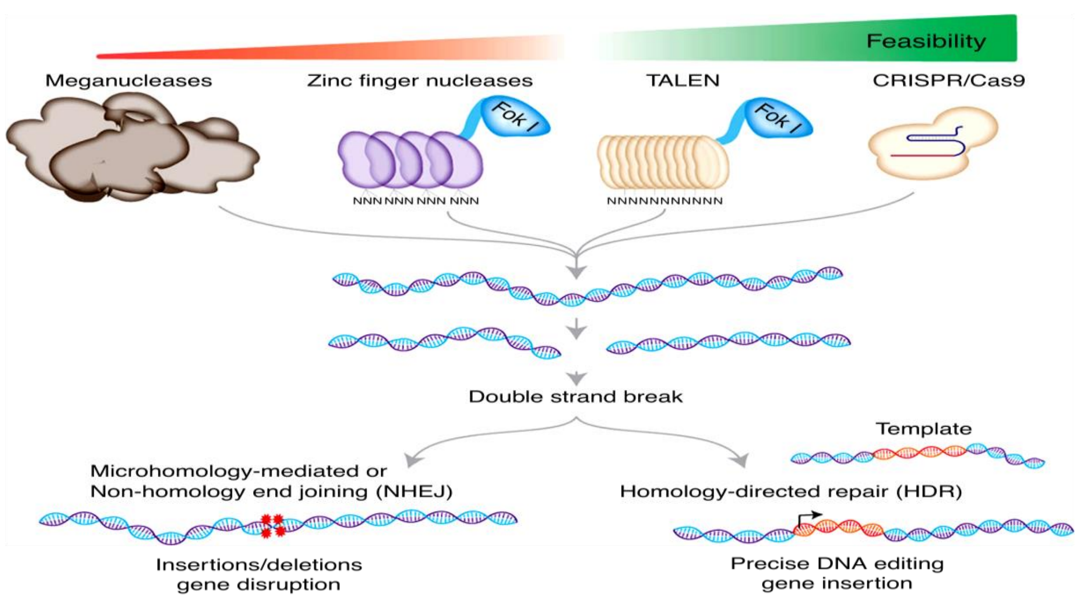

Fig 1: The different generations of nucleases used for genome editing and the DNA repair pathways used to modify target DNA

e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

- Genome editing with engineered nucleases, *i.e.* all three major classes of these enzymes—zinc finger nucleases (ZFNs), transcription activator-like effector nucleases (TALENs) and engineered meganucleases—were selected by *Nature Methods* as the 2011 Method of the Year. The CRISPR-Cas system was selected by *Science* as 2015 Breakthrough of the Year.
- In May 2019, lawyers in China reported, in light of the purported creation by Chinese scientist He Jiankui of the first gene-edited humans (see Lulu and Nana controversy), the drafting of regulations that anyone manipulating the human genome by gene-editing techniques, like CRISPR, would be held responsible for any related adverse consequences. A cautionary perspective on the possible blind spots and risks of CRISPR and related biotechnologies has been recently discussed, focusing on the stochastic nature of cellular control processes (https://en.wikipedia.org).

What is CRISPR-Cas9?

- CRISPR is Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) and their associated proteins (Cas) display a prokaryotic adaptive immune system that memorizes previous infections by integrating short sequences of invading genomes—termed spacers—into the CRISPR locus. The spacers interspaced with repeats are expressed as small guide CRISPR RNAs (crRNAs) that are employed by Cas proteins to target invaders sequence-specifically upon a reoccurring infection (Hille and Charpentier, 2016).
- The CRISPR/Cas consists of the Cas nuclease and two individual RNA components, a programmable crRNA (CRISPR RNA) and a fixed tracrRNA (trans-activating crRNA). Cas protein is able to cut the invading phage DNA into small fragments, which are then integrated into the CRISPR array as a spacer. Subsequently, the CRISPR array is transcribed to generate crRNA and a complementary tracrRNA, which form a double-stranded RNA structure that recruits Cas proteins for cleavage. Adjacent to the crRNA-targeted sequence on the invading DNA, a short sequence named as the protospacer adjacent motif (PAM) plays an essential role in the adaptation and interference stages, which the CRISPR/Cas complex recognizes during target DNA binding. The absence of a PAM sequence can alter the affinity between Cas and the target DNA, since specific PAM sequence recognition serves to discriminate non self-target sequences from non-target sequences (Mei *et al.*, 2016).

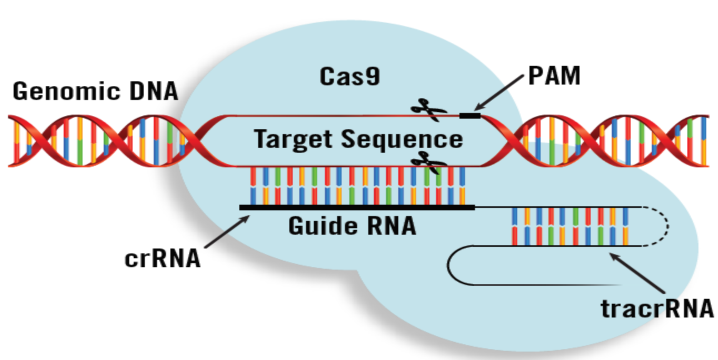

Fig 2: The CRISPR/Cas9 RNP complex

History of CRISPR

- 1987 1st report on repetitive sequences (CRISPR, Ishano *et al*.)
- 2000 CRISPR present throughout prokaryotes (Mojica *et al*.)
- 2005 Foreign elements, proposed immunity function (Mojica *et al*.)
- 2010 Cas9 is guided by spacer and induces DSB in target (Garneau *et al*.)
- 2011 Heterologous expression of CRISPR type II (Sapranauskas *et al*.)
- 2012 Proposal CRISPR for Genome editing (Jinek, Doudna, Charpentier*et al*.)
- 2013 CRISPR used for genome editing in eukaryotic cells (Zhang *et al*.)
- 2014 Crystal structure of Cas9 gRNA complex (Nishimasu, Zhang *et al*.)

Molecular mechanisms of CRISCPR/Cas9

- The CRISPR-Cas system acts in a sequence-specific manner by recognizing and cleaving foreign DNA or RNA. The defense mechanism can be divided into three stages: (i) adaptation or spacer acquisition, (ii) crRNA biogenesis, and (iii) target interference.

A) **Adaptation:** In a first phase, a distinct sequence of the invading MGE called a protospacer is incorporated into the CRISPR array yielding a new spacer. This event enables the host organism to memorize the intruder's genetic material and displays the adaptive nature of this immune system. Two proteins, Cas1 and Cas2, seem to be ubiquitously involved in the spacer acquisition process as they can be found in almost all CRISPR-Cas types. Exceptions are the type III-C, III-D and IV CRISPR-Cas systems, which harbour no homologous proteins.

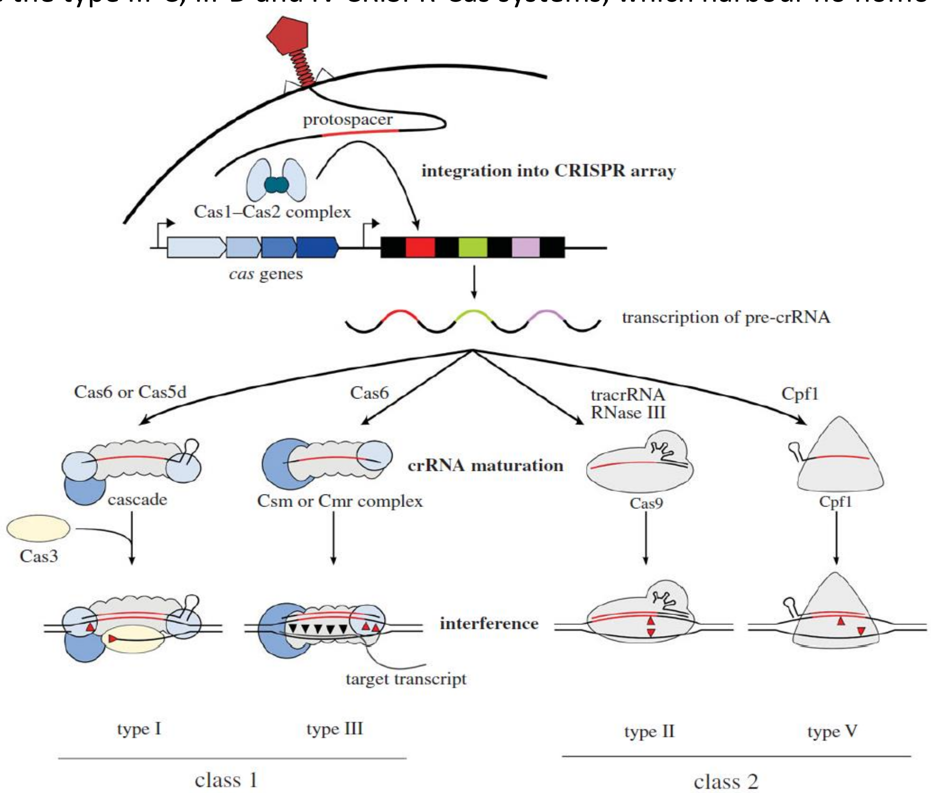

Fig 3: The molecular mechanism of CRISPR/Cas

B) **Biogenesis:** To enable immunity, the CRISPR array is transcribed into a long precursor crRNA (pre-crRNA) that is further processed into mature guide crRNAs containing the memorized sequences of invaders. **In type I and III systems**, members of the Cas6 family perform the processing step yielding intermediate species of crRNAs that are flanked by a short 5' tag. The protein Cas5d processes pre-crRNA resulting in intermediate crRNAs with an 11 nt 50 tag. Further trimming of the 30 end of the intermediate crRNA by an unknown nuclease can occur and yields mature crRNA species composed of a full spacer portion (50 end) and a repeat-portion (30 end), which usually displays a hairpin structure in most type I systems. The maturation of crRNAs in class 2 CRISPR-Cas systems differs significantly. **In type II systems**, tracrRNA is required for the processing of the pre-crRNA. The anti-repeat sequence of this RNA enables the formation of an RNA duplex with each of the repeats of the pre-crRNA, which is stabilized by Cas9. The duplex is then recognized and processed by the host RNase III yielding an intermediate form of crRNA that undergoes further maturation by a still unknown mechanism to lead to the mature small guide RNA. **In the type V-A** CRISPR-Cas system, it has been shown that Cpf1 has a dual function during CRISPR/Cas immunity. Cpf1 processes premature crRNAs and, following a further maturation event of unknown nature, uses the processed crRNAs that it has generated to cleave target DNA.

C) **Interferences:** In the last stage of immunity, mature crRNAs are used as guides to specifically interfere with the invading nucleic acids. Class 1 systems employ Cascade (CRISPR-associated complex for antiviral defense)-like complexes to achieve target degradation, while in class 2 systems, a single effector protein is sufficient for target interference. To avoid self-targeting, type I, II and V systems specifically recognize the PAM sequence that is located upstream (types I and V) or downstream (type II) of the protospacer. In type III systems, the discrimination between self and non-self is achieved via the 50 tag of the mature crRNA, which must not base pair with the target to enable degradation by the complex.

Application

- CRISPR in agriculture
- CRISPR in gene therapy and medicine
- Gene silencing
- DNA free CRISPR/Cas9 gene editing
- Homology directed repair
- Transient gene silencing or transcriptional repression
- Transient activation of endogenous gene
- Embryonic stem cell and transgenic animal
- Pooled genome-scale knockout screening

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 Volume 2 – Issue 2 – February 2020

The Genetically Modified Crop: Boon or Bane

Article id: 22984

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INTRODUCTION

Agricultural innovation has always led to productivity and sustainability production. The biotechnological approach has added a new dimension to such innovation, thereby providing a highly efficient and cost-effective means of producing crops with new features. The new technology is referred as Transgenic in the above sense. The fundamental principle behind this technology is to combine into a single specific crop the diverse range of novel properties of different crops or their organisms. These are genetically engineered crops for higher yields, disease and pest resistance, taste, color, scale, etc. The genetic engineering is carried out by introducing into the target plant the DNA originating from any organism of interest. A lot of work has been done so far to confer characteristics on plants such as herbicide resistance, insect resistance, resistance to disease and tolerance to stress. Nevertheless, there is a growing interest in plant development of drugs and industrial proteins as well as improving plant nutrition.

The first step in making a transgenic crop is the transfer of desired DNA through the use of enzymes or molecular scissors to cut or extract a gene section from the DNA chain. The second step is to use the molecular scissors to cut an opening in the recipient DNA where the gene can be inserted. As both the gene fragment and the recipient DNA cut ends are chemically "sticky," they are bound to each other creating a chain of DNA containing the new gene of interest. The third step is to complete the process in which another enzyme is used to protect the current new gene.

In 1993, a virus-resistant tobacco was the first genetically engineered plant to be commercialized and cultivated in China. Flavr Savr tomato, the first transgenic food crop, produced by the Calgene Company in 1994.Transgenic Crops such as Bt Cotton contain the Bacillus thurengensis (*Bt*) gene which makes it bollworm resistant. Golden rice, with β-carotene gene which is precursor for vitamin A, Round-up Ready crops with herbicide (Glyphosate) resistance.

Pros of Genetically modified crops

- **Herbicide tolerance:** It reduces herbicide usage, thereby preventing damage to the environment.
- **Immunity to disease:** GM crops may be immune to plant disease caused by fungi, bacteria and viruses.
- **Resistance to pesticides:** It minimizes the use of chemical pesticides and also reduces the crop's increasing costs.
- **Nutrition:** It also enhances the nutritional quality of produce.

e-ISSN: 2581 - 8317 **Volume 2 – Issue 2 – February 2020**

- **Phytoremediation:** some genetically engineered plants can clean up contaminated soil from heavy metal pollution.
- **Pharmaceuticals:** It offers edible vaccines and drugs in crop plant products to make delivery, storage and administration simpler than conventional injectable vaccines.

Cons of genetically modified crops

- **Resistance in target organism:** Due to the prevalence of the same genetically modified crops for resistance to pests, resistance may increase in the target pests.
- **Gene transfer to other species:** some scientists are also concerned about the transfer of the herbicide resistance gene to weeds leading to the development of "superweed" in nature.
- **Threat for non-target organisms:** with the poison they produce, some of the pest-resistant crops can destroy non-target insects.
- **Ethical issues:** some of the genes used in transgenic crops are derived from animal sources leading to a boycott by some people's society of these plant products.

Future prospects:

Producing longer shelf life and improved plant taste. Allergen-free food crops such as grains, fruits and vegetables with improved nutrition will be key interest. Production of crops with medicinal property and enhanced mineral content like iron and zinc would be research goal.

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AGRICULTURE & FOOD: e- Newsletter
www.agrifoodmagazine.co.in
e-ISSN: 2581 - 8317 **Volume 2 – Issue 2 – February 2020**

Fighting with Hidden Hunger through Nutritional security offered by crop biofortification

Article id: 22985

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INTRODUCTION

Malnutrition has emerged as one of the world's most serious health problems. Consumption of nutritionally deficient unbalanced diet causes malnutrition that is more prevalent in underdeveloped and developing countries. Protein deficiency, essential amino acids, vitamins and minerals lead to poor health and increased vulnerability to various diseases, resulting in significant losses in Gross Domestic Product and affecting the country's socio-economic structure. While different avenues are available such as dietary diversification, food fortification and medical supplementation, biofortification of crop varieties is regarded as the most sustainable And cost-effective strategy in which nutrients naturally meet target people. In addition to serving as an important source of livelihood for poor people, the newly developed biofortified crop varieties assume great importance in nutritional welfare. More than two billion people worldwide are suffering from "hidden hunger" or shortages in micronutrients. We don't get enough of the foods they eat to lead healthy, productive lives. Vitamins and minerals like vitamin A, calcium, and iron are micronutrients. Even though they're just needed in very small quantities by the body, they are essential for good health and disease prevention. It is not possible to see many of the signs of micronutrient deficiencies such as lower IQ, reduced disease resistance, and fatigue. This type of malnutrition is therefore called "hidden hunger."

Vitamin A deficiency

Approximately 30% of children in pre-school age are deficient in vitamin A and nearly 5.2 million children in pre-school age are suffering from night blindness. A recent article in Lancet attributed vitamin A deficiency to 105,700 childhood deaths in 2013. Among developing countries, more than 19 million pregnant women are also deficient in vitamin A and 9.7 million are clinically night-blind. Biofortified vitamin A staple crops such as maize, cassava and sweet potato can provide 50% to 100% of a child's daily needs for vitamin A. Eating biofortified orange sweet potato decreases child diarrhea incidence and duration. The intake of orange sweet potato also increases the status of vitamin A in children and reduces the likelihood of vitamin A in women.

Zinc deficiency

Billions of people over 17% of the world's population are at risk of insufficient intake of zinc. In Sub-Saharan Africa and South Asia, the prevalence of insufficient zinc intake is estimated to between 25 percent and 29 percent. Specific zinc deficiency prevalence measurements are rare as the suggested zinc deficiency measurement tool is not commonly used. Stunting is widely used as a proxy for estimating a population's risk of zinc deficiency. Around 23 percent of pre-school-age children are globally stunted. Many biofortified zinc rice and zinc wheat varieties are now available or tested worldwide, including India, Bangladesh and Pakistan. Zinc from biofortified rice and wheat consumed by the body is significantly higher than from traditional varieties. In India, the intake of zinc wheat decreases mother and child morbidity.

Iron deficiency

Iron deficiency is the world's most common deficiency of micronutrients and a leading cause of anemia. Globally, 800 million women and children are affected by anemia. Biofortified beans contain as popular varieties up to twice the amount of iron. High-iron beans in young women avoid and reverse iron deficiency. Eating twice a day can provide up to 75% of the daily iron needs of a woman. High iron pearl millet in India allows school-age children to reverse iron deficiency and improve their cognitive performance.

CONCLUSION

Biofortified crops have been bred for having higher amounts of micronutrients; which is helpful to provide important vitamins and minerals. These are effective in reducing hidden hunger and are an integral component of food-based strategies, including dietary diversification, supplementation, and industrial fortification, to enhance nutrition and food security.

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AGRICULTURE & FOOD e-NEWSLETTER

e-ISSN: 2581 - 8317

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2020

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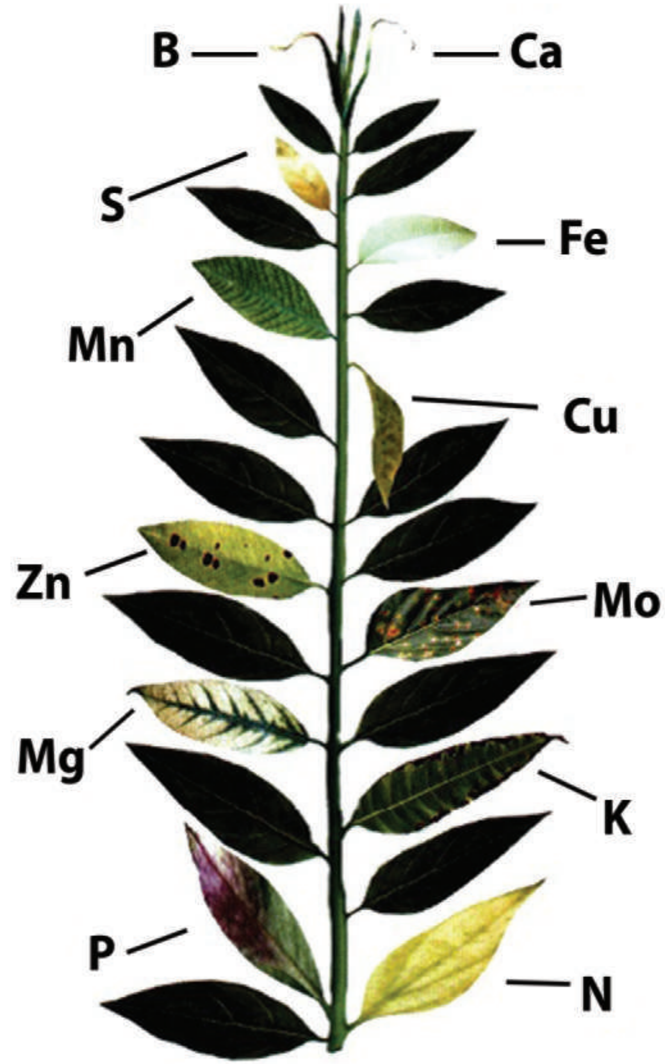

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Articles which are sent to us without proper format would be automatically rejected

Maximum page limit: 2-5 pages

Times New Roman, 12 font, 1 spacing

Title of article (must be short and catchy)

Author's (s) name

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Summary of Article: 1 – 2 paragraphs

Introduction: may contain multiple paragraphs, figures, tables and HD images.

***Tables which are uploaded in image form are not accepted.**

*** Reference in text must be like**

- → **ABCDEFG HIJK LMNO PQR (Singh *et. al.*, 2015)**
- → **ABCDEFG HIJK LMNO PQR (Singh *and Mishra,* 2015)**
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- → **Singh *and Mishra,* 2015) found that ABCDEFG HIJK LMNO PQR**

Personal opinion column can be added

Summary/ Conclusion:

HD Photographs (if available)

References format:

[1]. Dutta R.N., (1984). Comparative ecological study of makhana in Darbangha region. Ph.D. thesis. Ranchi University, Ranchi Bihar.

[2]. Ho H., Cheu Y. and Luo I., (1953). The detection of vitamin B, and C in Chinese drugs. *Journal of Taiwan Pharmacy Association*. 5(1):5-20.