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INDEX

Agriculture & Food: e-Newsletter Volume 03 – Issue 11 – November 2021
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INDEX

Agriculture & Food: e-Newsletter Volume 03 – Issue 11 – November 2021
www.agrifoodmagazine.co.in

INDEX

Agriculture & Food: e-Newsletter Volume 03 – Issue 11 – November 2021
www.agrifoodmagazine.co.in

INDEX

Agriculture & Food: e-Newsletter Volume 03 – Issue 11 – November 2021
www.agrifoodmagazine.co.in

INDEX

Agriculture & Food: e-Newsletter Volume 03 – Issue 11 – November 2021
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Agriculture and Climate Change

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Onuwa, G.C
Department of Agricultural Extension and Management, Federal College of Forestry, Jos, Plateau state, Nigeria
onuwag@gmail.com

INTRODUCTION

The agricultural sector is one of the largest contributors to greenhouse gas emissions, second only to the energy sector (World Bank, 2008a). Conversely, climate change affects agriculture throughout the world. According to the fourth assessment report of the Inter-governmental Panel on Climate Change, crop yield loss as a result of climate change will be more severe in the tropics than in temperate regions. Estimates indicate that between 75 million and 250 million people in Africa will be affected by water shortages caused by climate changed (FAO 2007). As in any situation of economic imbalance, the poor will be the most affected - losing livelihood opportunities and access to land and water. Many mitigation and adaptation measures are beyond the reach of countries with severe resource constraints. Livestock and crops emit carbon dioxide, methane and nitrous oxide making agriculture a major source of greenhouse gases. Some 80% of these emissions come from developing countries. Agriculture is also a major cause of deforestation according to reports of the United Nations Framework Convention on Climate Change. Nitrous oxide emissions from soils, because of the use of fertilizers and manures and methane from livestock production account for a third of non-carbon dioxide emissions. Land use change, compounded by agriculture, also reduces carbon sequestration (World Bank, 2008a). In light of the foregoing, the agricultural sector faces multiple challenges. While intensification and diversification of agriculture is germane to achieving food security; the absence of information on their impacts can be problematic. Though measures to reduce the use of fertilizers, to increase organic inputs and to deploy new varieties of crops are suggested as better agronomic practices, more clarity is required regarding their impacts on climate.

Agricultural Adaptation and Mitigation

Adaptation to climate change should be considered from a contingency planning process perspective. Adaptation in the agricultural sector can be seen in terms of both short-term and long-term actions. The provision of crop and livestock insurance, social safety nets, new irrigation schemes and local management strategies, as well as research and development of stress resistant crop varieties form the core of short-term responses. Long-term responses include re-designing irrigation systems, developing land management systems and raising finances to sustain adoption of those systems (FAO, 2005). Agriculture could also benefit from emerging areas of climate change action. For example, the selection of rice varieties that include wetland rice in sub-Saharan Africa can reduce deforestation as well as management costs and emissions (IIAPA, 2002). Also, it could profit from the benefits of land uses that sequester carbon, from the emerging markets for trading carbon emissions. Such activities offer higher returns than those arising from forest conversion to agricultural land. Post-2012 discussions under the

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Kyoto Protocol to the United Nations Framework Convention on Climate Change might consider exploring credits for the sequestration of carbon in soils through conservation tillage in agriculture as well as agroforestry in agricultural landscapes (World Bank, 2008b). Livestock improvements brought about by more research on ruminant animals, storage and capture technologies for manure and conversion of emissions into biogas are additional contributions that agriculture can mate towards mitigating climate change (FAO, 2006).

CONCLUSION

Many least developed countries have had the opportunity to develop National Adaptation Plans of Action in the context of the United Nations Framework Convention on Climate Change but implementation of those programmes and strategic links to resourcing actions are often lacking. National agricultural priority setting should consider climate change responses; while the biophysical impacts of climate change on agriculture and vice versa are better understood. With increasing trade distortions and the changing priontization of agriculture in developed countries, developing countries affected by climate change should focus on developing suitable national, regional and global measures that will provide a safety net in the short term, should productivity fail owing to climate variability and change. Institutional and human resource capacities supported by sustained funding options in the form of direct or indirect investments into adaptation to climate change in agriculture are essential. Mainstreaming climate change issues into national economic and development plans is critical to enabling countries tackle the impacts of climate change on agriculture and reducing the negative effects of agricultural practices on climate change.

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Proso Millet: Therapeutic Effects and Nutritional Health Security

Article ID: 35000

Jharana Panda[1], Anjali Yadav[1]
[1]Research Scholar, Department of Food and Nutrition, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar-848125.

Proso millet (*Panicum miliaceum)* is a short duration crop with relatively low water requirement. It is believed to be the first domesticated cereal grain and one of the oldest human foods. Proso millet was widely cultivated in Asia and Africa around 7000 years ago during the Neolithic era. This crop is generally grown in the kharif season but it can also be grown as a summer catch crop where irrigation facilities are available.

Basic Information Regarding Proso Millet

Origin	Probably originated from Manchuria, China
Family	Poaceae
Botanical name	*Panicum miliaceum*
Common name	"Broomcorn millet", "Common millet", "Hog millet" and "White millet"
Duration of crop	60-90 days

Local Names of Proso Millet

Language	Local Names
Hindi	"Barri", "Chena"
Gujarati	"Cheno"
Bengali	"Cheena"
Odia	"Bachari", "Bagmu"
Telugu	"Variga"
Kannada	"Baragu"
Tamil	"Pani Varagu"
Punjabi	"Cheena"
Malayalam	"Panivaragu"

Health Benefits of Proso Millet

Proso millet is nutritious and delicious. The bran of proso millet contains vital nutrients that are essential for a healthy diet and is also an excellent source of fibre. It is gluten free and has a significant amount of carbohydrates, protein, niacin and fatty acids. Apart from these nutrients, it also contains essential minerals like phosphorus, manganese, iron, zinc and magnesium. The nutritional profile of proso millet per 100g is shown below:

Nutrient	Amount/100g
Protein (g)	12.50
Fat (g)	1.10
Crude fibre (g)	2.20
Carbohydrate (g)	70.40
Energy (Kcal)	341.00
Calcium (mg)	14.00
Phosphorus (mg)	206.00
Iron (mg)	0.8.
Magnesium (mg)	153.00
Zinc (mg)	1.40
Niacin (mg)	2.30

The Health Benefits of Proso Millet are

1. Good for nervous system: Proso millet is rich in lecithin. Lecithin is a complex compound that indirectly promotes and maintains the nervous system's proper functioning. Memory diseases such as dementia and Alzheimer's disease are treated with lecithin.

2. Good for celiac patients: Celiac disease is a condition in which a person is allergic to gluten containing foods. And proso millet is a gluten free grain, thus it can be consumed by patients suffering from celiac disease.

3. Helps in reducing blood cholesterol level: Proso millet helps in raising the High-Density Lipoprotein (HDL) levels in the body. The presence of HDL boosts cholesterol metabolism and aids in keeping cholesterol under control. Proso millet also contains phytic acid that helps in reducing bad cholesterol i.e., Low Density Lipoprotein (LDL) levels in the body.

4. Beneficial in preventing pellagra: Pellagra is a skin disease which causes the skin to become dry, scaly and rough. This is caused due to deficiency of niacin (Vitamin B_3). And, proso millet has a very high content of niacin. Thus, people who are niacin deficient can reduce the deficiency by consuming daily portions of proso millet.

5. Proso millet also has anti-ageing properties: It contains antioxidants that help in removing free radicals from the body. Including this millet in regular diet thus can help in delaying the process of ageing.

6. Beneficial in reducing risk of diabetes: Proso millet is rich in magnesium, which helps in keeping a check on blood glucose level and regulates healthy insulin level in the body and thus helps in reducing the risk of Type-II diabetes.

7. Proso millet contains significant amount of protein: (12.5g/100g of grains). It helps to stay in shape as protein is the building block of bones, skins and muscles. Protein also helps in building and repairing the tissues in the body.

8. Strengthens bones: Proso millet is a source of calcium which is essential for strengthening the bone. It can provide calcium to the children whose bones are in developing phase. Proso millet is also perfect for the older people as they also require sufficient amount of calcium for good bone maintenance.

Cultivation of Proso Millet

Before the beginning of intensive farming of wheat and rice, proso millet was the main food crop. Proso millet was the earliest dry crop cultivated in East Asia due to its high resistance to drought and this attribute has helped in its widespread. The characteristics that make proso millet good for farmers are:

1. This crop is generally well adapted to low rainfall regimes, short growing seasons and can grow in poor soil conditions. So, it fits well in marginal environments. This crop is unique from other millet crop as it requires less water to grow.

2. It is highly resilient in adapting to different ecological conditions. In future, it can address the climate change issue and is ideal for contingency plantings.

3. It is a farmer-friendly crop. It has been observed in many tribal communities that, the farmers do two important things for growing millet crops. One is broadcasting of the seeds/grains and the other is the harvest of this crop after short duration. And for this type of cultivation, this millet is well suited. Proso millet is often considered as "Lazy Farmer Crop".

4. Proso millet is a rain-fed crop grown in dry land farming conditions but also responds well to irrigation. As compared to other traditional crops in terms of yield, this millet crop is good. Proso millet has the potential to give yield up to 20-23 quintal per hectare.

Conclusion

Proso millet is one of the miracle grains having several environmental and health benefits. It can play an important role in global food security under changing climate due to its high drought resistance and nutrient rich characteristics. Adoption of a proso millet diet can potentially prevent deterioration of human health resulting from a sedentary lifestyle. Although several studies on proso millet have been done, industrial application of this millet grain is still facing major competition. Production and market gaps will only be overcome by educating people about prospects of proso millet including nutritional and environmental values.

Curry Leaves (*Murraya koenigii*): A Versatile Multi-Potential Medicinal Plant

Article ID: 35001

Dr. Pankaj Kumar Ray[1]

[1]Subject Matter Specialist (Horticulture), Krishi Vigyan Kendra, Agwanpur, Saharsa, Bihar, (Bihar Agricultural University, Sabour, Bhagalpur, Bihar).

Abstract

Because of tremendous increase in human population which is thought to reach about 9.6 billion by 2050, it becomes a need of the hour to promote the use of plant-based products or their extracts for the benefit of mankind. Indians regard food (vegetables, fruits, spices, medicinal plants) as a source of supporting system for body's healing processes. Traditional system of Indian medicine, known as Ayurveda play an important role in the treatment of wide variety of diseases. There has been tremendous growth in field of herbal medicine as therapeutic agents. Today it is gaining popularity in western countries because of negligible side effects, low costs, easy availability and rapid rate of biodegradability. All the plants are thoroughly studied before they can be employed for Ayurvedic pharmacopeia. One such plant of Indian origin, *Murraya Koenigii*, is known to possess ethnomedicinal properties and has been used for centuries in the Ayurvedic system of medicine.

Introduction

Murraya koenigii, commonly known as curry leaf or karipatta in Indian dialects, belonging to Family Rutaceae which represents more than 150 genera and 1600 species (Satyavati *et al.,* 1987). *Murraya koenigii* is a valuable plant for its characteristic aroma and medicinal value. It is an important export commodity from India as it fetches good foreign revenue. A number of chemical constituents from every part of the plant have been extracted. The most important chemical constituents responsible for its intense characteristic aroma are Pgurjunene, P-caryophyllene, P-elemene and O-phellandrene.

The plant is rich source for carbazole alkaloids. Bioactive coumarins, acridine alkaloids and carbazole alkaloids from family Rutaceae were reviewed by Ito, 2000. *Murraya koenigii* is widely used in Indian cookery from centuries and have a versatile role to play in traditional medicine. The plant is credited with tonic and stomachic properties. Bark and roots are used as stimulant and externally to cure eruptions and bites of poisonous animals. Green leaves are eaten raw for cure of dysentery, diarrhoea and vomiting. Leaves and roots are also used traditionally as bitter, anthelmintic, analgesic, curing piles, inflammation, itching and are useful in leucoderma and blood disorders.

Several systematic scientific studies are also being conducted regarding the efficacy of whole plant or its parts in different extract forms for the treatment of different diseases. *Murraya koenigii* contains a number of chemical constituents that interact in a complex way to elicit their pharmacodynamic response. A number of active constituents responsible for the medicinal properties have been isolated and characterized. This plant has been reported to have anti-oxidative, cytotoxic, antimicrobial, antibacterial, anti-ulcer, positive inotropic and cholesterol reducing activities (Shrinivasan, 2005). Therefore, the present review summarizes the available literature till date on isolation of phytoconstituents, biological activities of the isolated compounds and pharmacological actions of extracts along with the clinical studies.

Murraya koenigii (Rutaceae) commonly known as Meethi neem, is an aromatic more or less deciduous shrub or a small tree up to 6 m in height found throughout India up to an altitude of 1500 m and are cultivated for its aromatic leaves. In traditional system of Medicine, it is used as antiemetic, antidiarrhoeal, dysentery, febrifuge, blood purifier, tonic, stomachic, flavoring agent in curries and chetneys. The oil is used externally for bruises, eruption, in soap and perfume industry. The phytoconstituents isolated so far from the leaves are alkaloids viz., mahanine, koenine, koenigine, koenidine, girinimbiol, girinimibine, koenimbine, O-methyl murrayamine A, Omethyl mahanine, isomahanine, bismahanine, bispyrayafoline and other phytoconstituents such as coumarin glycoside viz., scopotin, murrayanine, calcium, phosphorus, iron, thiamine, riboflavin, niacin, vitamin C, carotene and oxalic acid.

The essential oil from leaves yielded di- alpha phellandrene, D-sabinene, D-_-pinene, dipentene, D-_-terpinol and caryophyllene. It is reported to possess antioxidant, antibacterial, antifungal, larvicidal, anticarcinogenic, hypoglycemic, anti-lipid peroxidative, hypolipidemic, antihypertensive activity and proactive effect against carbon tetra chloride- induced hepatic damage in rats38. It is also reported to contain 5, 8-dimethylfuranocoumarin, 1- al, 3[6', 6' dimethyl 5-hexene] carbazole and _-sitosterol (Sumit *et al*., 2009).

Plant Description and Habitat

The plant is distributed and cultivated throughout India. It is found wild from Himalaya's, Uttarakhand, Sikkim to Garhwal, Bengal, Assam, Western Ghats and Travancore- Cochin. Propagation is done by seeds, which germinate freely under partial shade. Is also available in other part of Asian region like in moist forests of 500- 1600 mheightin Guangdong, S Hainan, S Yunnan (Xishuangbanna), Bhutan, Laos, Nepal, Pakistan, Sri Lanka, Thailand, Vietnamurraya Together with South Indian immigrants, curry leaves reached Malaysia, South Africa and Réunionisland. Outside the Indian sphere of influence, they are rarely found. *Murraya koenigii* is an unarmed, semi deciduous aromatic shrub or small tree with slender but strong woody stem and branches covered with dark grey bark, leaves are imparipinnate, glabrous, and very strongly aromatic. Leaflets 9-25 or more, short stalked, alternate, gland dotted and strongly aromatic. The stem of *Murraya koenigii* is an aromatic and more or less deciduous shrub or small tree upto 7 meters in height and 14 to 42 cm in diameter. The main stem is dark green to brownish. The bark of the stem can be peeled off longitudinally which exposes the white wood underneath. Flowers are small, white fragrant ebracteate, calyx deeply five clefts, pubescent. Petals five, free, whitish, glabrous and with dotted glands. Fruits occur in close clusters, small ovoid or subglobose, glandular, thin pericarp enclosing one or two seeds having spinach green color (Raghunathan and Mitra, 1982).

Traditional Uses

Fresh leaves, dried leaf powder, and essential oil are widely used for flavouring soups, curries, fish and meat dishes, eggs dishes, traditional curry powder blends, seasoning and ready to use other food preparations. The essential oil is also utilized by soap and cosmetic aromatherapy industry. Curry leaves are boiled with coconut oil till they are reduced to blanked residue which is then used as an excellent hair tonic for retaining natural hair tone and stimulating hair growth. It is traditionally used as a whole or in parts as antiemetics, antidiarrheal, febrifuge, blood purifier, antifungal, depressant, anti-inflammatory, body aches, for kidney pain and vomiting (Rao *et al*., 2011).

Pharmacological Studies

Antibacterial activity: The essential oil from *Murraya koenigii* leaves showed antibacterial effect against *B. subtilis*, *S. aureus*, *C. pyogenes*, *P. vulgaris* and *Pasteurella multocida*. The pure oil was active against the first three organisms even at a dilution of 1: 500. The acetone extract of the fresh leaves of *Murraya koenigii* on fractionation gives three bioactive carbazole alkaloids named as mahanimbine, murrayanol and mahanine, which has shown mosquitocidal, antimicrobial and topoisomerase I and II inhibition activities (Narasimhan *et al*., 1975).

Antifungal activity: The essential oil from leaves of *Murraya koenigii* showed antifungal activity against *C. albicans*, *C. tropicalis*, *A. niger*, *A. fumigates*, *Microsporum gypseum* and *Murraya koenigii* was effective against C. albicans even at a dilution of 1:500. The ethanolic extract of the leaves showed fungitoxicity against Colletotrichum falcatum and Rhizoctonia solani. The ethanolic extract of the roots and also the whole plant excluding roots of *Murraya koenigii*, however, did not show any antifungal activity against Cryptococcus neoformans, Trichophyton mentagrophytes and Microsporum canis (Kishore *et al*., 1982).

Antiprotozoal activity: Ethanolic extracts (55 %) of *Murraya koenigii* whole plant excluding roots (extract A) and roots alone (extract B) were screened for their pharmacological actions. Extract A showed anti-protozoal action against Ent. Histolytica, antispasmodic effect on isolated guinea pig ileum, whereas extract B showed antiprotozoal activity against Ent. Histolytica and as well as antihypertensive activity in cat/dog (Parimi *et al*., 2014). (See table 1.).

Conclusion

Keeping in view the tremendous pharmacological activities and availability of literature, *Murraya koenigii* may be utilized to alleviate the symptoms of variety of diseases as evident from the pre-clinical data. Although crude extract from various parts of *Murraya koenigii* have numerous medical applications, modern drugs can be developed after extensive investigation of its bioactivity, mechanism of action, pharmaco-therapeutics, toxicity and after proper standardization and clinical trials. The available literature and wide spread availability of *Murraya koenigii* in India thus makes it an attractive candidate for further pre-clinical and clinical research.

Table-1. Active compounds of *Murraya koenigii* and their activities:

M. koenigii compounds	Source	Biological activity
Lutein	Leaves	Antioxidant activity
Tocopherol	Leaves	Antioxidant activity
	Leaves	Hepatoprotective
Carotene	Leaves	Antioxidant activity
Koenimbine	Leaves	Antioxidant activity
Isomahanine	Leaves	Anticaries
Mahanine	Stem and bark	Antimicrobial
Murrayanol	Leaves	Mosquitocidal
	Leaves	Anti-microbial
Murrayanine	Stem bark	Antifungal
Girinimbine	Stem bark	Anti-cancer
	Stem bark	Antifungal and antibacterial
	Leaves	Hepatoprotective

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Bacterial Volatile Compounds: Poison for Plant Pathogens

Article ID: 35002

Tensirani Pradhan[1]
[1]Assistant Professor, Plant Pathology, GIET University, Gunupur, Rayagada, Odisha.

Introduction

Current agricultural practices for pest and disease control depend on a wide use of pesticides, bactericides, and fungicides which is not environment friendly and sustainable in the long run. Increased demand for organic products indicates consumer preference for reduced chemical use. Therefore, there is a need to develop novel sustainable strategies for crop protection and enhancement that do not rely on genetic modification and/or harmful chemicals. The production of antifungal substances by bacteria has long been recognized and this knowledge has entered practical life through the use of bacterial antagonists to protect crops against their fungal enemies. Recently, it has become clear that in addition to diffusible substances, bacteria emit a wide range of volatile compounds into the atmosphere. These volatiles are not only able to promote plant growth, but also to strongly inhibit fungal growth. As the demand for organic products and the need to render agriculture more sustainable are rising, finding new environmentally friendly crop protection strategies is essential. In this perspective, the newly discovered capacity of bacterial volatiles to efficiently repel phytopathogenic fungi in laboratory experiments holds great promise.

Bacterial Volatile Compounds

Bacteria can release molecules of low molecular weight (<300 Da) and high vapor pressure (0.01 kPa at 20◦C) that can readily evaporate and diffuse through heterogeneous mixtures of solids, liquids and gases (Schulz and Dickschat, 2007). These volatile organic compounds are lipophilic in nature and also possess low boiling point. Bacterial volatile compounds are generally produced by catabolic pathways, including glycolysis, proteolysis and lipolysis, and belong to different chemical classes.

Classification

Microbial volatile organic compounds can be classified into various groups based on the functional group. The pie diagram given below (Fig. 1.) shows that alcohols are the most abundant volatile group followed by aromatic compounds, ketones, and organic acids.

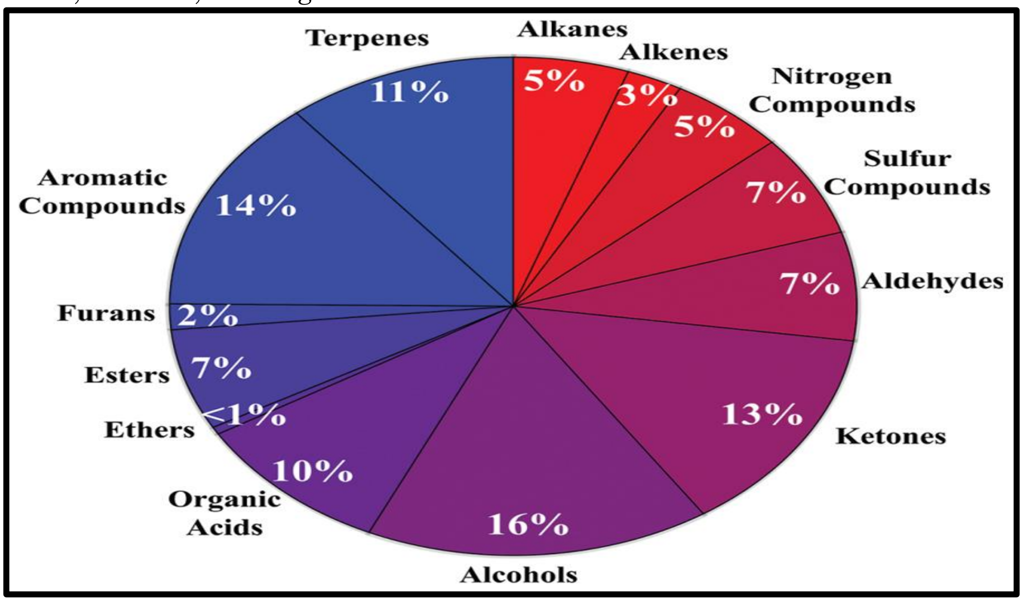

Fig. 1. Classification of Volatile Compounds based on the functional group

Examples of Antagonistic BVCs Against Plant Pathogens

Bacterial VOCsact against a broad spectrum of pathogenic fungi and bacteria. The results obtained when exposing disease-causing agents to bacterial volatiles are summarized in Table 1. So far, mostly *Bacillus, Pseudomonas* and *Streptomyces* species have been reported to efficiently inhibit the growth of phytopathogenic fungi, while members of other genera (e.g., *Burkholderia, Serratia, Agrobacterium*) have only sporadically been investigated.

Table. 1. Examples of antagonistic bacterial volatile compounds against plant pathogens:

Volatile	Source	Target
Dimethyl trisulfide	*Bacillus cereus*	*Alternaria alternata*
1-octen-3-ol	*Paenibacillus polymyxa* BMP-11	*Alternaria brassicae*
Dimethyl disulfide	*Bacillus cereus*	*Botrytis cinerea*
Citronellol	*Paenibacillus polymyxa* BMP-11	*Fusarium oxysporum*
2,3-butanediol	*Pseudomonas chlororaphis* O6	*Erwinia carotovora* subsp. *carotovora*
2-butanone	*Bacillus cereus*	*Pseudomonas syringae* pv. *lachrymans*
3-Pentanol	*Bacillus amyloliquefaciens*IN937a	*Xanthomonas axonopodis* pv. *vesicatoria*

Role of Bacterial Volatile Compounds in Plant Disease Management

Bacterial volatiles protect plants either by direct antagonism or by inducing systemic resistance. Through direct antagonism, antifungal volatiles can inhibit mycelial growth and pigmentation in phytopathogenic fungi like *Fusarium oxysporum* (Liu *et. al*., 2008). Mu *et. al.,* (2017) reported that volatiles from *Bacillus subtilis* induced morphological abnormalities in the hyphae of *Botrytis cinerea.* These volatiles can also impair the sporulation and germination of phytopathogenic fungi (Hunzeiker *et. al*., 2015). Likewise, antibacterial volatiles can adversely affect ultra-structure and virulence-related characteristics like twitching motility, swarming motility, swimming motility and chemotaxis of plant pathogenic fungi like *Ralstonia solanacearum* (Tahir *et al*., 2017).

Bacterial volatiles at lower dosage protects plants by inducing systemic resistance rather than direct pathogen inhibition (Huang *et al*.,2012). Induced systemic resistance is the major mechanism of volatile mediated plant protection. The ISR signaling pathways could differ based on the volatile profile released by different bacteria and can be salicylic acid, jasmonic acid or ethylene signaling (Sharifi and Ryu, 2016).

Advantages and Disadvantages of Bacterial Volatiles

Bacterial volatile Compounds being volatile in nature play an important role in long distance antagonism. Compared to soluble compounds that accumulate around the producing cells, volatiles can diffuse easily via air- and gas-filled pores in the soil and play a role in long-distance microbial interactions. Volatiles can have synergistic effects with soluble antimicrobials which can be used for the management of soil borne, post-harvest and foliar diseases. It also leaves very less residual effect as compared to other chemical fungicides. However, it has certain disadvantages like high target specificity, volatilization losses and human health problems.

Future Perspectives

Bacterial volatile compounds offer a great potential for sustainable crop protection as environment friendly alternative to the deleterious pesticides. However, the research on the application of bacterial volatiles and the combination of volatiles and soluble compounds in agriculture is still in its infancy. The successful isolation of bacterial volatiles depends crucially on the extraction and purification protocol and is often hindered by the low concentration or chemical instability of highly active natural products. New developments in genomics, mass spectrometry and imaging offer solutions to these restrictions, allowing direct metabolite analysis, even at the level of single cells. Greater progress is required to conduct the experiments from *in vitro* closed conditions to open-field studies with relevance for large-scale agricultural applications.

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Harpins: As Elicitor of Defence Response

Article ID: 35003

Tensirani Pradhan[1]
[1]Assistant Professor, Plant Pathology, GIET University, Gunupur, Rayagada, Odisha.

Introduction

Harpins are glycine-rich and heat-stable proteins that are secreted through the type III secretion system in pathogenic bacteria. Gram-negative plant-pathogenic bacteria use a sophisticated system to secrete proteins during interaction with host plants to cause diseases. This is called the type III secretion system (T3SS), in which structural proteins are encoded by hypersensitive response and pathogenicity (*hrp)* genes (Tampakaki et al. 2010).

These *hrp* genes encode two types of secreted proteins:
1. Effector proteins that are delivered into plant cells.
2. Extracellular accessary proteins including harpins. In certain plant species or cultivars, effector proteins can be recognized by corresponding disease resistance (R) proteins and induce the hypersensitive response (HR) as a potent resistance mechanism in plants.

General Characteristics of Harpins

Harpins are unique proteins that share common characteristics, which are distinct from other bacterial proteins: First, in terms of amino acid composition in harpins, they carry a relatively high amount of glycine and serine residues, whereas they carry no or few cysteines and few aromatic amino acids. Second, in terms of secondary structures, harpins are predicted to have several regions of α-helices.

Third, harpins are very acidic, based on their theoretical isoelectric points, with the exception of HopAK1 and HpaXm. Fourth, the sizes of harpins from Xanthomonas spp. are significantly smaller than those from Erwinia- and Pseudomonas-related bacteria.

Finally, harpins are heat stable, probably due to the lack of obvious tertiary structures stabilized by cysteine bridges as described above. However, this characteristic has made it relatively easy to purify harpins to produce cell-free elicitor preparation, because the HR elicitor activity of harpins remains active even after boiling for 15 min.

Functions

Harpins as virulence factors of bacterial pathogens: Harpins are highly expressed during infection of plants or in apoplast-mimicking medium indicating that harpins do play a role in the interaction with plants**.** Based on mutational analysis, some harpins have been reported to have virulence functions in host plants. Mutation of the *hrpN gene by* transposon insertion in *E. amylovora* reduced virulence but this mutant still retained significant virulence in host plants (Barny 1995). However, the mutant, in which *hrpN* gene had been deleted from *E. amylovora*, blighted less than 3% of apple shoot length compared with 80% blighted by the wild-type strain and also did not trigger disease symptoms on immature pear fruits (Sinn et al. 2008).

Harpins as a part of translocator complexes for effector translocation into plant cells: Harpins act as translocators facilitating the injection of bacterial effector proteins into plant cells. DspA/E is a critical effector of *E.* amylovora for disease development, and its translocation into host cells was severely impaired in the *E. amylovora hrpN* mutant (Bocsanczy et al. 2008). AvrPto is a well-characterized effector of *P. syringae* pv. *tomato*, and it acts as a virulence factor by inhibiting plant innate immunity (Zipfel and Rathjen 2008).

Association of harpins with cell membranes: Several harpins can bind to lipids and form pores in the plant plasma membrane. PopA1 from *R. solanacearum* was shown to be integrated into liposomes and also membranes from *Xenopus laevis* oocytes*, resulting in the formation of ion-conducting* pores (Racape et al.

2005). *P. syringae* HrpZ1*, E. amylovora* HrpN*,* and *X. campestris* HreX were shown to be able to form pores in liposomes, and the intact protein was required for pore formation (Engelhardt et al. 2009).

Harpins as elicitors of HR cell death in apoplast of plant tissues: All harpins reported thus far, except XopA of *Xanthomonas campestris pv. vesicatoria (Kim et al. 2004)* and HrpZ1 of *P. syringae pv. tabaci (Tsunemi et al. 2011),* can induce an HR in tobacco following infiltration of leaf panels. Intensive studies on HR elicitation with several harpins revealed that certain regions of harpins are sufficient for HR elicitation.

Harpins as inducers of defense responses without HR in plants: When harpin genes are constitutively expressed in plant cells or harpins are sprayed on plants, they confer defense responses to diverse plant pathogens without HR cell death. Foliar application of the full-length Hpa1 and, particularly, Hpa1$_{10\text{-}42}$ fragment induced strong resistance in rice to *X. oryzae pv. oryzae and Magnaporthe grisea in greenhouse* and field conditions (Chen et al. 2008).

Harpins as plant growth enhancers: In addition to induction of HR and defense responses, harpins can also stimulate plant growth. Extracellularly localized harpins can enhance plant growth through ethylene-dependent signaling pathways. Foliar application of *X. oryzae pv. oryzicola Hpa1* protein was shown to enhance grain yield as well as plant growth in rice (Chen et al. 2008).

Future Perspectives

Harpins are unique and multifunctional proteins that play critical roles in the interactions between bacterial pathogens and plants. Harpins also trigger diverse beneficial responses when sprayed or expressed in plants. Although diverse functions of harpins have been identified, how they have these effects on plants remains to be determined.

First, what are the relationships between harpins and other translocator proteins? Second, is there any specificity between harpins and other translocators in terms of effector translocation? How is each translocator complex connected with Hrp pilus in vivo and how does it regulate effector proteins? These questions will help us understand the interface between bacterial pathogens and plant cells. Third, how do harpins elicit diverse responses in plants?

In addition to HR, defense responses, and growth enhancement, harpins were recently shown to increase drought tolerance in rice. Are there specific host targets to regulate each response in plants? If any targets are present, what they are doing and where they are acting will be important questions to answer.

Fourth, what is the biological significance of glycine richness and lack of cysteine in harpins? Due to these features of harpins, it is generally considered that the structures of harpins are very flexible, and this flexibility might be one explanation for why harpins can be involved in diverse responses in plants.

Finally, should harpins be considered as apoplastic effectors, pathogen-associated molecular patterns (PAMPs), or both? Harpins are secreted through T3SS and trigger defense responses and HR cell death like effectors. At the same time, harpins are very abundant proteins and can induce expression of marker genes and callose deposition like PAMPs. Further studies on the molecular mechanism of harpin functions will shed much needed light on the roles that harpins play in plant–microbe interactions.

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Classification of Unmanned Aerial Vehicles

Article ID: 35004

Srinidhi. G[1], Sushilendra[1], Sunil Shirwal[1], Vijayakumar Palled[1]
[1]Department of Farm Machinery and Power Engineering, College of Agricultural Engineering, University of Agricultural Sciences, Raichur (Karnataka), India.

Introduction

Unmanned aerial vehicles are used in real-world applications such cargo delivery, traffic surveillance, moving object detection, and agriculture for nutrient status, crop damage, and pest attack detection, among others. UAVs are made up of aircraft parts like sensors, payloads, and a ground control station. Onboard electronic equipment or remote controls can be used to keep an eye on them. Precision agriculture technology use unmanned aerial vehicles (UAVs) to minimize crop damage and preserve crop output. Kites, balloons, high clearance tractors, unmanned aeroplanes, and helicopters have all been employed as unmanned aerial vehicles. All of these platforms are equipped with image capture devices and location measuring receivers, allowing them to fly over agricultural farms and other targeted areas, snapping images as needed.

Unmanned Aerial Vehicle

Unmanned Aerial Vehicles (UAVs) are aircraft that do not have a human pilot. Its flight is either handled remotely by a pilot on the ground or autonomously by computers.

Classification of UAV

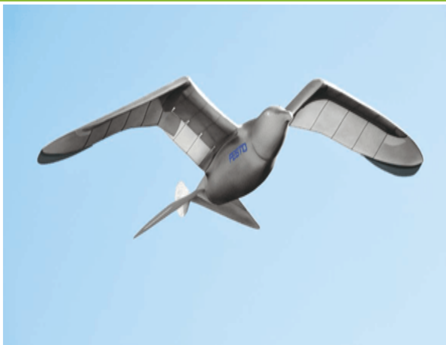
1. Based on Aerodynamics: Aerodynamics is a branch of science concerned with the mobility of air and other gaseous fluids, as well as the forces acting on moving bodies.

a. Fixed wing drones:

i. They are very simple but saturated in designing and manufacturing, because of successful generalization of larger fixed-wing planes with slight modifications and improvements.
ii. Fixed wings are the main lift generating elements in response to forward accelerating speed.
iii. The velocity and steeper angle of air flowing over the fixed wings controls the lift produced.
iv. The fixed wing drones require a higher initial speed, less power requirement and the thrust to load ratio of less than 1 to initiate a flight.
v. Fixed wing drones cannot hover at a place, and they cannot maintain their low speed.
vi. Fixed wing drones are more compatible with larger L/D ratio and with higher Reynolds number.

b. Flapping wing drones:

i. Flapping wing drones are primarily inspired by insects such as small hummingbirds to large dragonflies
ii. Flapping drones can support stable flights in a windy condition, unlike fixed-wing drone.
iii. Light, flexible and flapper wings provide the flapper motion with an actuation mechanism.



c. Ducted Fan:

i. Ducted fan UAVs with vertical takeoff and landing provide many advantages to their equivalent fixed- and open-wing counterparts.

ii. When it comes to safety, payload, and scalability, the ducted fan UAV is incomparable.

d. Multirotor:

i. Main rotor blade produces a forceful thrust, which is used for both lifting and propelling.

ii. Multirotor unmanned aerial vehicles are capable of vertical takeoff and Landing (VTOL) and may hover at a place unlike fixed-wing aircraft.

iii. Multirotor are designed by number and location of motors and propellers on the frame. Their hovering capability, ability to maintain the speed makes them ideal for surveillance purpose and monitoring.

Tricopter	A multi rotor aircraft having three rotors and disadvantage of it is unstable.	
Quadcopter	A drone with four horizontal propellers or rotors	
Hexacopter	A multi rotor aircraft having six rotors in which the beauty	
Octocopter	A drone with 8 horizontal propellers or rotors	

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2. Based on Landing:

a. Horizontal takeoff and landing (HTOL): HTOL may be considered as the extension of fixed-wing aircraft. They have high cruise speed and a smooth landing.

b. Vertical takeoff and Landing (VTOL): VTOL drones are expert in flying, landing and hovering vertically they are limited by cruise speed because of the slowing down of retreating propellers.

Horizontal takeoff and landing (HTOL)

Vertical takeoff and Landing (VTOL)

3. Based on weight and range: UAV are classified based on the weight and range. The different types of UAV are tabulated below.

Type	Maximum Weight	Maximum Range	Category
Nano	200 g	5 Km	Fixed wing, Multirotor
Micro	2 Kg	25Km	Fixed wing, Multirotor
Mini	20 Kg	40 Km	Fixed wing, Multirotor
Light	50 Kg	70 Km	Fixed wing, Multirotor
Small	150 Kg	150 Km	Fixed wing
Tactical	600 Kg	150 km	Fixed wing
MALE	1000 Kg	200 Km	Fixed wing
HALE	1000 Kg	250 Km	Fixed wing
Heavy	2000Kg	1000 Km	Fixed wing
Super Heavy	2500 Kg	1500 Km	Fixed wing

Conclusion

The next generation is reliant on unmanned aerial vehicles (UAVs). They are going to start a new market. Almost all business areas, including precision agriculture, logistics, and infrastructures, are upgrading and adopting UAVs. Future technologies will focus on extending endurance and payload, as well as improving human-UAV interaction and establishing clear laws and regulations for the safe and secure operating of UAVs. Aside from that, combining artificial intelligence with drone technology will allow the drone to make decisions without relying on human controllers.

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Agri-Entrepreneurship

Article ID: 35005

Kharche P. P.[1], Salgar S. B.[1]
[1]Ph.D Scholar, Department of Agronomy, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri.

What is Agri-Entrepreneurship?

In order to increase income a person organises, starts, operates and controls a venture is entrepreneur. He/ she can be innovator/ service provider and desires to maximize profits by selling the product/ idea/ service to people/ consumers. An agri-entrepreneur is not different he/ she is an innovator/ service provider who focuses on organizing, starting, operating and controlling a commercial business in Agriculture sector. The activity may involve agriculture and allied agricultural activities. This refers to an individual's characteristic by virtue of which he has an intense desire and will power to achieve the goal of earning most benefit by undertaking innovative activities of crop production and allied enterprises like livestock, poultry, fishery, duckery, bee keeping, horticulture, rabbitory, mushroom cultivation etc. Agri-entrepreneurship not only buying and selling of raw agriculture products but also agri-value addition in order to improve standard of living of a farming community by actively engaging oneself in profitable and innovative agricultural enterprises warranting consistent hard work and adequate risk bearing ability.

How to Bring About Agri-Entrepreneurship in Agriculture?

There are different ways to bring agri-entrepreneurship in agriculture. The most important three of them are:

1. Change the prevalent method of doing (learn how to do):

a. Learning from various sources like SAU publications, KVK technology transfer, trainings conducted by Government bodies as well as NGO's in particular area, visiting Kisan melas, progressive farmers in village, consultancy and other audio visual modes of transfer of technology in agriculture (Mobile application, radio and TV programmes)

b. Use of modern agriculture practices including high yield varieties, integrated pest, weed and disease management, resource management, maintaining soil health.

c. Market led agriculture: grow what sells in market, growing according to the demands in market. Growing different crops which can be cultivated in a particular agro-climatic region (exotic fruits and vegetable in demand now days).

d. For capital formation taking loans from Government institutes and making sincere repayments.

e. Maintaining records of the farm inputs and outputs (expenditure and income) and calculating the remunerative enterprises as well as to come with improvement strategies for non-remunerative enterprises.

2. Changing the dimension of agriculture:

a. Crop diversification: Crop diversification is introduction of latest crops or cropping systems to agricultural production on a specific farm taking under consideration the varied returns obtained from value addition of crops with complementary marketing effects. This not only provides diversified products but also a balanced food to the farm family. Besides it also saves from complete failure of a particular crop due to external conditions (biotic and abiotic stress).

b. Farm diversification: Farm diversification consists of taking up of allied agricultural activities along with crop production, such as horticulture, livestock, poultry, mushroom cultivation, apiculture, pisciculture, etc, on a piece of land, allocation of suitable area for each enterprise, so that there is efficient recycling of residues in the system which means output or by-product of one enterprise acts as input for the other one, as far as possible. In fact, such kind of symbiotic combination of agricultural production enterprises is not a new practice, but the same has already been practised by our farming community since time immemorial depending upon their need, interest, culture and capability. The question always remains with the farmer about which is the most suitable combination of enterprises in his condition taking into consideration of the resources available, agro-climatic conditions and strength, weakness, opportunities and threat (SWOT) in his farm conditions. There are many peer reviews that integrated farming system has played a role in increasing, stabilising farmers income as well as generating year-round employment to farming family.

c. Occupational/Role diversification: Farmer or farming community is known for their producer role only. Sale of crop produces to market middlemen which causes distress sale of produce i.e., selling at lower prices. There is need to diversify role by farmers such as producer, processor, value added and marketer may be referred to as occupational/role diversification. By involving themselves in various roles of value addition and marketing of the farm produce or value-added products to the nearest point of final consumers as far as possible, farmers can help create a lot of employment opportunities and enhance income for themselves and also for others. For this, farmers should learn skill sets of production, processing and marketing, and practise them gainfully, either locally or outside.

d. Types of value addition:

i. Time value addition: selling farm produce not at harvest time when there is glut in the market, but in times of relative scarcity to obtain a premium price.

ii. Place value addition: selling farm produce at a place where a premium price can be obtained.

iii. Form value addition: transforming the farm produce into different product of consumer preference (processing) to obtain premium price.

iv. Possession value addition: advertising the product as if being in the possession/use of the popular and trustworthy celebrity to obtain premium price.

3. Changing the mindset/attitude of agriculturists:

a. Developing an intense urge to earn more and more by dint of consistent hard work. Minute observation of activities of those who remained successful in their lives and learning from and emulating them, and also learning factors of failure from those who could not succeed in their endeavour.

b. Breaking one's socio-psychological and personal barrier to undertaking any profitable enterprise irrespective of its apparent social recognition/non- recognition.

c. Learning and inculcation of characteristics of entrepreneurship in oneself.

d. Building self-help group (SHG) for a common cause, going ahead individually is difficult.

Inculcating belief in participatory/collective development rather than individual standalone development.

Characteristics of an Agri-Entrepreneur

There are characteristics of an agri-entrepreneur, which aren't easy to possess and execute. So as to boost standard of living of a farming community and increasing also as steady and stable income to farmers an agri-enterpreneur must possess those qualities and characters. A decent agri-entrepreneur must have all the characteristics of excellent person. In other words, if a person does not fulfil characteristics of an honest person, he cannot consider becoming a good entrepreneur. Perfection in entrepreneurship may be a myth, but as far as possible, one should attempt to imbibe those characteristics so as to achieve prosperity by working within the field of agriculture sector. Following could be a list of excellent character of an agri-entrepreneur he should value time, money, energy, target setter, target oriented and committed, hardworking, enthusiastic, innovative, confident, market led, well behaved, temperamental, active, passionate, positive, punctual, consistent, progressive, polite, etc.

There are a couple of barriers to agri-entrepreneurship development by farmers. These must be overcome by them as far as possible to venture into arena of agri-entrepreneurship. These could also be classified as follows:

1. Physical: Problem of farmers' and their families' health, which of rural infrastructure like connectivity, electricity, irrigation/water facility, etc.

2. Individual/personal: Laziness and unwillingness to try to to unconventional work of profit, lack of risk and responsibility bearing capacity.

3. Family: lack of support/encouragement from family to require up some enterprise beyond production sector.
4. Social: there's lack of support/ encouragement from the society, which the entrepreneur is related to, to require up some enterprise. repeatedly, following entrepreneurship to be forbidden for individual, as per societal protocol.
5. Economic: Lack of capital for initial fixed investment and meeting operational expenditure.
6. Religious/cultural: Religious/cultural restriction to set up some enterprise.
7. Educational: Lack of education reduces risk and responsibility bearing capacity, self-confidence/ faith to build up some enterprise.

Conclusion

For bringing about agri-entrepreneurship, farmers must adopt strategies like (1) changing the strategy (do how) of agriculture, (2) changing the dimension of agriculture, and (3) changing their mindset/attitude (self-reform). However, there are a couple of barriers to agri-entrepreneurship development, like physical, individual/ personal, family, social, economic, religious/ cultural, educational, etc., which must be overcome as far as possible to achieve farm prosperity.

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Contract Farming

Article ID: 35006

Salgar S. B.[1]
[1]Department of Agronomy, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra - (413722).

Introduction

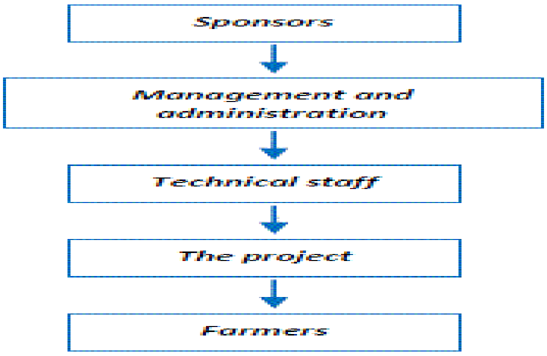
For millions of Indians, farming is a traditional source of income. Farmers have to throw away their product on occasion due to a lack of purchasers. This is one of the coin's two sides. The agro-based and food industries, on the other hand, rely on timely and sufficient inputs of high-quality agricultural output. This underlying contradiction of India's agricultural situation has given rise to the notion of contract farming.

Definition of Contract Farming

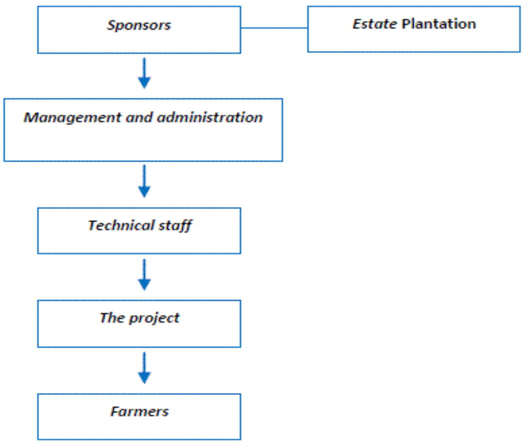
Involves agricultural production being carried out on the basis of an agreement between the buyer and farm producer. Sometimes it involves the buyer specifying the quality required and the price with the farmer agreeing to deliver at future date.

Model of Contract Farming: (Manjunatha, *et al.,* 2016)

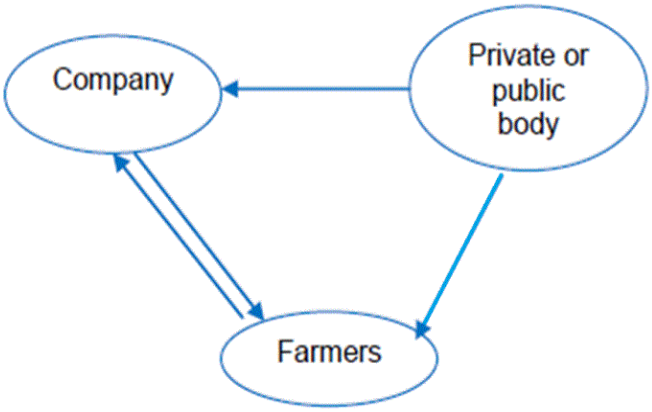
1. Centralized Model: Model is used in developing countries for high value crops such as tobacco, cotton, banana, coffee, tea, cocoa, or rubber. The contracting company provides necessary support to the farmers for the production of required crops; purchases the crop from the farmers; and then packages and markets the product while tightly controlling its quality. It is vertically organized, with strict quality control and quota allocation.



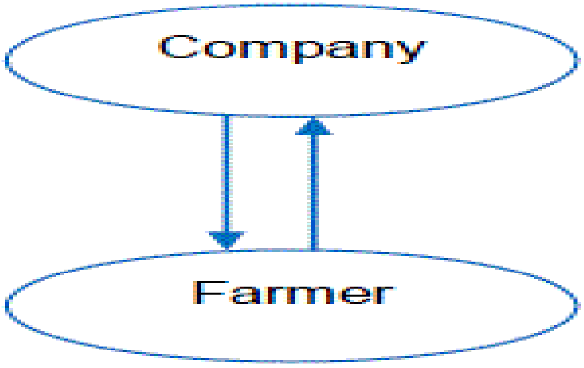
2. Nucleus estate model: This is a variation of the centralized model. To ensure a limited assurance of needed production, the company owns and maintains an estate plantation. It is generally employed to ensure processing plant throughput, but it is also utilized for research and breeding purposes. This strategy works well for products like tea, coffee, rubber, cocoa, sugar, and oil palm, as well as fresh vegetables and fruits, with which farmers may have little or no expertise.



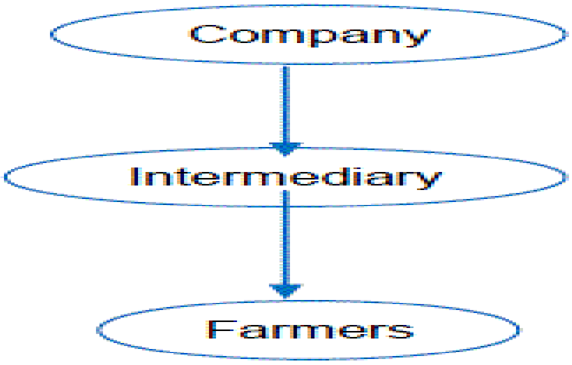
3. Multipartite model: This type of model can involve a variety of organizations, including statutory bodies, and can emerge from centralized or nucleus estate models, for example, through the formation of farmer cooperatives or the participation of a financial institution. Various commodities and services, including as credit, inputs, machineries, equipment, transportation, processing, and marketing facilities, may be provided by each business.



4. Informal model: It consists of small businesses or enterprises that enter into seasonal informal contracts with farmers, primarily for commodities such as fresh vegetables or tropical fruits. It frequently necessitates government assistance, such as research and extension, which has a higher danger of extra contractual marketing. In most cases, the business has relatively little participation in real production and input procurement.



5. Intermediary model: Companies establish formal sub-contracts for crop production with intermediaries (such as agents, farmer's organizations, or NGOs) under this approach, and there is a risk that the sponsor loses control over output and quality, as well as the prices paid by farmers. In most cases, intermediaries engage into informal relationships with farmers in order to fulfill their duties under formal contracts with corporations.



Advantages to the Farmers: (Wagh, 2017)

1. Provision of inputs and production services.
2. Access to credit.
3. Introduction of appropriate technology.

4. Skill transfer.
5. Guaranteed and fixed pricing structures.
6. Access to reliable markets.

Disadvantage to the Farmers

1. Increased risk.
2. Unsuitable technology and crop incompatibility.
3. Manipulation of quotas and quality specifications.
4. Corruption.
5. Domination by monopolies.
6. Indebtedness and over reliance on advances.

Advantages to the Sponsors

1. Small-scale contract farming is more politically acceptable.
2. Overcome the Land constraints
3. Production is more dependable than open-market purchases, and because the sponsoring business is not responsible for production.
4. More consistence quality can be obtained.
5. An uninterrupted and consistent supply of raw materials.
6. The firm will be protected from market price fluctuations.
7. The firm will be able to establish long-term planning.

Disadvantages to the Sponsors

1. Due to a lack of security of tenure, contracted farmers may encounter land restrictions.
2. Social and cultural restrictions may affect produce for specification.
3. Poor management and a lack of communication with farmers.
4. Farmers may sell outside of the contract (extra-contractual marketing).
5. Farmers may redirect credit-supplied supplies to other uses, resulting in lower yields.

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Role of Plant Tissue Culture for Crop Improvement, Protection and Disease-Free Planting Material

Article ID: 35007

Shivani Chaudhary[1]
[1]Ph. D. Scholar, Department of Plant Pathology, S.V.P.U.A.T., Meerut, U.P.

Introduction

Tissue culture was discovered at the start of the 20th century with the work of Gottleib Haberlandt (plants) and Alexis Carrel (animals). In 1952, for the elimination of viral infection in Dahlia tissue culture technique was applied by Morel and Martin. It is a technique for growing plant cells, tissues, organs, seeds or other plant parts on a nutrient medium in sterile environment.

It is used to eliminate virus germplasm from the infected plants/tissues that is commonly found in cassava, potato, sweet potato and ornamental plants. Crop protection technology is extremely important in modern agriculture. On one hand the infections increase because of which the geographical area shrinks and if this prevails for longer time then it will become difficult to feed the growing populations. The problem is serious, and the only way to find a reliable solution is to employ suitable biotechnological approaches. It is now easy to create disease-resistant and disease-free plants for future use because of advances in biotechnology methods.

All genetic alterations involving plant systems can be done by tissue culture as it is an important platform. The technique has assisted transformation experiments leading to transgenics, starting with unpretentious callus induction, root and shoot regeneration. In this totipotency characteristic is used.

The Steps for Producing New Plants is as Follows

1. A tiny bit of plant tissue is removed from the plant's apical tip and put on a sterile media containing nutrients and hormones resulting in the tissue to form a shapeless mass known as callus.
2. The callus is then transferred to another media comprising plant hormones that promote root development.
3. The callus with grown roots is then positioned on another media containing various hormones that encourage the growth of shoots.
4. The callus, that has roots and shoots, divided into small plantlets.
5. The plantlets are then relocated into pots or soil where they can develop into full plants.

Various Types of Tissue Culture

1. Seed Culture.
2. Embryo Culture.
3. Callus Culture.
4. Organ Culture.
5. Protoplast Culture.

Steps Involved in Tissue Culture Techniques

1. Selection of plant.
2. Isolation of explant.
3. Sterilization of explant.
4. Inoculation of explant.
5. Incubation.
6. Initiation of callus.
7. Sub-culturing.
8. Regeneration.
9. Hardening.

Applications in Crop Improvement

1. Accomplish broader crosses with a higher number of related wild plant species to gain access to a much wider variety of genes that may be exploited for crop plant genetic improvement.
2. Assistances in the bulk development of plants that are difficult to cultivate.
3. Helps in the fast multiplication of ornamentals, fruits, and aromatics.
4. For QTL analysis creates "Double Haploid" mapping populations.
5. Provides plant breeders with an impressive number of attractive germplasms.
6. A important technique for regeneration and the formation of artificial seeds.
7. Used to create virus-free plants.
8. Production of secondary metabolites like Nicotine from *Nicotiana rustica*.
9. Using embryo rescue approach, interspecific and intergeneric hybrids can be produced.
10. Broadly utilized for DNA transformation, because the cell wall would otherwise stop DNA from entering the cell.

Usage of Tissue Culture Techniques in Plant Protection

Tissue culture includes the production of haploids, the development of genetic diversity (somaclonal variation), somatic hybrids, genetically modified plants, and micropropagation. *In vitro* techniques suggest a tool for DNA-mediated intervention, variant selection, and clone development. A well-organized method of eliminating the virus is the incubation of apical meristems. Because of this the technology of apical meristem cultivation has been successfully functional. In certain situations, the terminal and axillary/lateral buds are also reachable for meristem culture.

Transgenic Plants

A gene which has been transferred from one organism to another through genetic engineering is known as transgene. Transgenic organism is that in which transplanted genes is present in an organism. Plantlets are being created from Transgene-modified cells, and these plantlets can later develop into plants. Transgenic Bt has shown to be a treasured tool in the progress of an IPM program. Only Bt cotton is commercially available in India.

Advantages of Tissue Culture

1. By using little amount of plant tissue, plantlets can be produced in relatively short period of time.
2. The young plantlets are less likely to be infected.
3. In seed potato business, this method helps in the maintenance and establishment of virus-free stock.
4. The process can be carried out at any time of year.
5. It does not require a large amount of area to produce plants.
6. This approach is used to grow ornamental plants such as dahlias, chrysanthemums, orchids.

Conclusion

The plant tissue culture technique has been significantly donated to producing disease free planting materials of crops in many countries. Usage of this technique has generated the increase in productivity per unit area in crops but volume is inadequate to fulfill the high demand for the plantlets. The technology has formed numerous employment chances and unbolted up many entrepreneurial fields. Tissue culture has been one of the main technological tools and reasons that have contributed a lot to feed 7 billion people in the globe.

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Success Story on Enhancing the Productivity of Groundnut Through Adoption of Scientific Technology

Article ID: 35008

Dr Upesh Kumar[1]

[1]Senior Scientist & Head, Krishi VIgyan Kendra, Samoda- Ganwada, Taluka- Siddhopur, District- Patan (Gujarat).

Name of farmers	-	Sri Rohit Bhai Chaudhari
Fathers Name	-	Sri Savaji Bhai Chadhari
Age	-	35
Village & Taluka	-	Nagvasan, Siddhapur
Area	-	5.0 ha
Irrigated area	-	5.0 ha
Method of irrigation		Sprinkalar irrigation
Major crops	-	Kharif- Groundnut, Castor & Cluster bean Rabi- Wheat & Tobacco Zaid – Green gram

Mr Rohit Bhai Chaudhari is a farmer of Village – Nagvasan, Taluka – Siddhapur, District – Patan (Gujarat). He is a progressive farmers & working in the field of agriculture. After education, Mr Chaudhari was engaged in agriculture & he was regular touch with KVK scientist for taking latest agriculture technology for enhancing profitability in our farm. The main source of farm income of Mr Chaudhari is Field crops & good Dairy Farm. Under Field crop, he was grown castor & cotton as a case crop but he is not interested on growing of other oilseed crops like – Groundnut. He was cultivated groundnut only for home consumption. KVK Scientist regularly motivates for crop diversification & discuss about the profitability of groundnut as an oilseed crop. In 2016-17, KVK was conducted the demonstration under NMOOP programme on Package demonstration of groundnut & he was interested for cultivation of groundnut. He was actively participating the programme identification of problem for low production of green gram to implementation of demonstration.

Demonstrated Technology

Improved variety (GG-20) + Seed inoculation with *T viridae* @ 10gm/Kg seed + Soil inoculation with NPK liquid bio fertilizer along with *T viridae* @ 2.5 Kg/ Ha + RDF + IWM & IPM module.

Mr. R. B. Chaudhari are regularly touch with KVK scientist & timely impart the activity like seed treatment, sowing, timely & proper dose application of fertilizer, timely weed management, apply timely plant protection measure resulted enhance 29.61 % productivity of demonstrated plot as compared to their own practice.

Economic Impact

Yield (qtl/ha)			Net return (Rs/ha)		B:C ratio	
T1	T2	% Enhance	T1	T2	T1	T2
15.2	19.7	29.61	34450	47270	2.84	3.18
T1- Farmer's practice, T2- Recommended Practice.						

Action Photographs

Training programme

Field day

Integrated Management of Virus Diseases in Chill and Okra

Article ID: 35009

Ram Prawesh Prasad[1], Amba Kumari[1]
[1]Scientist, KVK Darbhanga (Dr. RPCAU, Pusa, Samastipur) Bihar - 847302.

Introduction

Vegetables become the parts of human diet and due to its nutritional nutraceutical benefits. The contribution of vegetables remains heights (59-61%) in horticulture crop production Area on vegetables production is progressively increasing due to its high demand and shorter crop duration.

As the production is increasing threats pose by biotic and abiotic factors are also increasing every day. among the biotic factors such as pests and diseases, viral diseases emerging as a major constraint in the changing climate scenario. At several instances viral diseases are causing severe disease penalty up to 100 %.

Developing management strategy for the management of insect transmitted virus diseases is found difficult due to following reasons: wide host range of both insect vectors and viruses; faster resistance development by the insect vectors; quicker evolution of viruses infecting vegetables; and availability of scanty resistance sources in crops plants. Hence integrated strategies involving host plant resistance, induced resistance, biological, cultural and chemical can be incorporated as viable components for management of viral diseases in vegetable crops with a view to reduce pesticide load in the environment.

Leaf Curl Diseases of Chilli

Chilli leaf curl disease caused by mono or bi-partite single-stranded DNA begomoviruses (chill leaf curl virus, pepper leaf curl Bangladesh virus and tomato leaf curl Joydebpur virus). The virus produces different type of symptoms like curling, mottling and distortion of leaves, flowers, fruits and affected plants are shorter than the healthy plants.

Leaf curl diseases of Chilli

Management of Vector Borne Virus Diseases in Chilli

1. Application of Neem cake @ 1.0 kg/m2 in the seed bed.
2. Use of tolerant/resistant cultivars like -Punjab lal, Punjab Surkh, BS-35.
3. Seed treatment with Imidacloprid @ 8gm/kg.
4. Spraying of Cyantraniliprole @ 1.8ml/liter 2-3 three days before Transplanting.
5. Seedling dip of Imidacloprid @ 0.5ml/L for 3o mins before transplanting.
6. Growing of two rows of maize/sorghum/pearl millet as border crop in the main field.
7. Covering of soil with black silver reflective polythene mulch.
8. Spray with Acephate @ 1.5 g/L + Neem Oil @ 2.0ml/L at 15 DAT.
9. Spray with Fipronil @ 1.0 ml/L + Neem Oil @ 2.0ml/L at 21 DAT.
10. Spray with Imidacloprid @ 2 g/15L + Neem oil @ 2.0ml/L at 28 DAT.

11. Spray with Cyantraniliprole @ 1.8ml/L at 35 DAT.
12. Repeat spraying of insecticide in above sequence at 7 days interval till fruit formation.

This treatment has found to reduce the leaf curl disease and mosaic disease. Also reduced insect populations of whitefly, aphids and thrips were observed compared to control.

Bhendi Yellow Vein Mosaic Disease

It is caused by mono and bi-partite single stranded DNA begomoviruses (Bhendi yellow vein mosaic virus, Bhendi yellow vein Delhi virus). The affected plant shows bleaching of vein and veinlets on leaves whereas interveinal areas remain green. Upon advancement of disease, entire plants become white. Infected plants remain stunted by producing bleached fruits of unmarketable quality. The disease incidence in all the cases range from 90-100 per cent during the dry season and losses may exceed 50 per cent.

Okra enation leaf curl disease is caused by monopartite single-stranded DNA begomovirus (Okra enation leaf curl virus) and is transmitted by whitefly causing upto 90% crop loss. The disease initially causes small pinhead enations on the under surface of the leaves. This is followed by a warty and rough texture of leaves, later leaves curl upwards. Affected plants show a twisting of the stem, petioles and lateral branches with leaves becoming thick and leathery. In severely infected plants, fruit setting drastically reduced and seeds may be aborted.

Leaf curl & Yellow vein mosaic virus disease of Okra

Management of Yellow Vein Mosaic Disease on Okra

1. Raising two rows of pearl millet as border crop 15 days before okra sowing.
2. Covering of soil with black silver reflective polythene mulch.
3. Use of tolerant/resistant cultivars -Punjab-7, Varsha Uphar, Hisar Unnat, HBH-142, Hisar Naveen, CO-3, Arka Anamika,Kashi Lila, Arka Abhaya, NDO-10 and Sheetla Upahar, Sheetla Jyoti, KashiPragati, Kashi Vibhuti, Kashi Bhairav, Kashi Mahima, Kashi Mohini.
4. Seed treatment with Virkon S @ 5g/l (as seed disinfectant) followed by Imidacloprid @ 3g/kg seeds after 24 hrs.
5. Installation of yellow sticky trap 1-2 traps/50 sq m at 15 DAS
6. Spray of Flonicamid 50 WG @ 0.3 g/l @ 17 DAS
7. Spray of boron 0.2% + zinc 0.5% (or micronutrient mix @ 2ml/l) + soil drenching of humic acid 5ml/l at 20 DAS.
8. Spray of Chlorantraniliprole 10 OD @ 1.8 ml/l at 27 DAS.
9. Spray of Fupyridifurone @ 2.5 ml/l at 35 DAS.
10. Spray of Neem insecticide 3-5 ml/l at 45 DAS.

This treatment was most effective in reducing the jassids, whitefly populations with highest marketable fruit yield. In integrated module the YVM disease was lowest as compared to untreated control.

Conclusion

Many potential elements of pest management in vegetable crops and others have been studied and recommended but most are not sufficiently advanced to be of value to end users in practical sense under field conditions. Role of IPM such as resistant varieties, natural plant products, bio-pesticides and natural enemies is imperative, otherwise we will continue to talk of alternative methods of control for another many years.

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Hulless Barley: A Potential Staple Functional Food

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S. K. Bishnoi[1], Madhu Patial[2], Dinesh Kumar[1], Rajendra Kumar[1], R. P. S. Verma[1]
[1]ICAR-Indian Institute of Wheat and Barley Research, Karnal.
[2]ICAR-Indian Institute of Agricultural Research, Regional Station, Shimla.

Introduction

The Medicine Net (https://www.medicinenet.com/functional_food/definition.htm) defines functional food as "A modified food that claims to improve health or well-being by providing benefit beyond that of the traditional nutrients it contains. Functional foods may include such items as cereals, breads, beverages that are fortified with vitamins, some herbs, and nutraceuticals." However, the first working definition of functional food was framed under the Japanese legislature in the year 1991 according to which the functional foods are the "foods for specified health use" abbreviated as FOSHU. The essential characteristics of functional food are that its intake is dietary, it has a specific health benefit (s)and it is essentially not a supplement. The major gratification that a functional food may confer are prevention of diseases, elevation of general health, growth and vitality as well as, eradication of deficiency and malnutrition. These advantages are primarily due to the quantity, quality or mere presence of a nutrient (protein, essential amino acids, vitamins, minerals, omega-3 fatty acids etc.) which are otherwise not present or insufficiently present in routine human diets. The disease prevention/health promotion/anti-ageing aspects of the functional foods is attributed to their rich fiber content and antioxidative properties also. The antioxidants are effective in neutralizing free radicals which are produced during the cellular metabolism and through cell damage may cause diseases such as cancer, cardio vascular or kidney related conditions, besides several others.

Since the dawn of the civilization, humans have knowingly or unknowingly realized the value of the functional foods and even primitive humans have used fruits, vegetables, nuts, seeds, pulses, whole cereals, herbs, spices, natural drinks etc. to remain healthy and to sustain vitality. The trend upholds still the modern era when the market is overflowing with different brands of medicinal or fortified juices, edible plant powders, dairy products, cereal grains and other products such as fortified eggs. In the recent past, many developing countries including India has achieved food self-sufficiency and now the focus is shifting towards food quality and eradication of the hidden hunger i.e., malnutrition and different types of deficiencies. Malnutrition and nutrient deficiencies are rampant in the developing world particularly among the growing children and women. Apart from this, prevalence of the life style diseases like hypertension, obesity and diabetes are high mainly due to an unbalanced cereal based (mainly rice and wheat) diet.

In such a scenario, the affordable diversification of the daily diet with a staple cereal qualifying for a functional food seems to be the easy alternative. Barley (*Hordeum vulgare*), is one such cereal grain that is readily available as a complementary choice. It is one of the first domesticated crop plant species which finds mention in most ancient scriptures including the oldest Rigveda (*Yava*). Currently, it is the fourth most important crop in terms of global production and consumption after maize, rice and wheat. As an agricultural crop, barley is one of the hardiest crops for survival on poor soils, adverse climatic regime such as cold, drought, salinity and craves minimum agronomic inputs making it a choice crop to withstand the onslaught of global climate change. The cultivation zone of barley extends widely from arctic and subarctic to subtropical regions. When displaced by wheat, particularly in the irrigated areas, barley has found a new niche role in nutraceuticals, brewing, distillery and ethanol fuel production making it as a potential industrial crop around the world, particularly the areas with poor fertility.

Importance of Barley as Functional Food

A functional food needs to be developed from crops like barley which are productive, high-yielding and economical compared to the mainstream staples. The nutritional composition of the barley has been presented in table 1. Not only as a sole functional staple food, barley can well be utilized as a functional ingredient to the main course diets. The major use of the global barley production is for animal feed (70%), malting (25%) and only remaining 5 % is used as human food augmenting the functional dietary needs. The genetic diversity in barley is so immense that each type of barley i.e., food, feed and malting purpose barley is morphologically and genetically very different with specific characteristic features and end use. Broadly, barley can be classified as two-row and six-row and hulled and hulless types. The two-row barley is the original type in which the central spike is fertile while the two lateral spikes in each row are sterile making only two rows produce the grains. On the other hand, the six-row type was a mutant selected during the course of evolution in which all the three spikelets in each of the two rows are fertile and thus all six spikelets produce the grains. The six-row varieties are the major ones which are used for animal feed while the two-row varieties are used for malting and brewing purposes.

The use of barley as human food is limited because of the tight adherence of the outer hull to the grain that needs to be removed mechanically before it can be used as a food either as a grain or for making flour. This type of barley called the "pearled barley" loses most of its outer aleurone layer and thus is low in nutrition quality but high in keeping and cooking quality. The hulless barley (also called naked barley), on the other hand have lemma and palea not adhered to the pericarp which is removed easily during the threshing of the grains thereby, making its processing as easy as that of wheat. The hulled condition is controlled by the *Nud* gene. Hulless barley varieties generally have higher grain beta glucan contents than hulled barley, but lower yields. Pearling is not required for use in health foods or daily diets and the health benefits are widely recognized. The aleurone layer in hulless barley remains intact making it more nutritious. The hulless barley constitutes a very small fraction of the total world barley production and is a staple food crop in the Himalayan region, the Andes, North and Sub-Saharan Africa (SSA), including north African countries and the Ethiopian highlands hilly areas of Central Asia and South-West Asia.

The naked/ hullless barley flour can be successfully blended with the wheat flour to enhance ß-glucan, phenolic compounds and antioxidant content although with a reduction in moldability and in the chapati making quality. Hulless barley is a staple grain having very low glycemic index, very high in soluble fiber particularly the beta glucan, has higher lysine content as compared to wheat and have medicinal properties witnessed from ancient times. The Ayurveda mentions it as dry, cold, heavy and sweet curing the diseases of urinary tract, fat metabolism and useful in *Pitta* and *Kaphadosha* including rhinitis, asthma, cough, pain and throat and skin disorders.

The main constituent of the hulless barley is starch (around 60%) and a protein content ranging from 8-16%. The protein quality of hulless barley comprises of a good balance of amino acids including the essential ones such as histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. It is low in total fat (2-3%) which makes its products having better shelf life and also better from health point of view. Barley contains many important minerals including zinc, calcium, iron, magnesium, manganese, phosphorus and selenium. Among these, Selenium, makes part of anti-oxidant properties of barley. The functional ingredients of barley grain include fibre, phenolic acids, flavonoids, phytosterols, alkylresorcinols, benzoxazinoids, lignans, tocol, and folate, which have antidiabetic, anticancer, anti-obesity, antioxidant, antiproliferative, and cholesterol lowering abilities, such as beta-glucan(2.40~7.42%) and total tocols (39.9~81.6 μg/g).

The major health benefits of wonder crop barley are in lowering blood cholesterol, blood pressure and blood sugar being low in glycemicindex. Consuming barley improves the HDL/LDL ratio thus lowering the risk of cardiovascular diseases and hypertension because of the presence of D-alpha-tocotrienol in the germ and aleurone that inhibits the cholesterol synthesis in liver. The soluble fibre on the other hand inhibits the absorption of dietary cholesterol precursors. The fibre can promote better blood sugar control and protect against conditions like diabetes, obesity, heart disease, and stroke. The importance of fiber is in regulation of acid reflux and prevention of many digestive track ailments such as diverticulitis, stomach ulcers and haemorrhoids. Fermentation by lactic acid bacteria of whole meal barley flours increased the concentration of "Lunasin" a promising polypeptide with anti-cancerous properties, which would suggest new possibilities for the formulation of functional foods. The anticancer property of beta-glucan present in barley has been studied in *in vivo* and *in vitro* systems. It has also been proposed that the beta glucan, soluble non starch polysaccharides, protein and starch composition of barley makes it a highly valued functional food for cancer, type II diabetes and cardiovascular diseases. The beta-glucan arabinoxylans, phenolics, flavonoids, anthocyanins vitamin E, zeaxanthin and lutein in barley act synergistically with other cellular molecules to prevent cancer. Barley sprouts have been found effective in controlling colon cancer in rats. Hulless barley can be consumed as boiled, sprouts, chapattis, porridges, *dalia*, and other products of the flour and grain including the flakes. Moreover, Barley grass i.e., seedling leaves just like wheat grass, when chewed raw or in the form of dried powder are highly health promoting and contains more than 30 functional nutrients including GABA (Gamma Aminobutyric Acid), flavonoids, potassium, calcium, vitamins, and tryptophan and is reported to be effective against a number of chronic diseases and therefore it also qualifies for a functional food.

Conclusion

The demand for staple functional foods which are economically sustainable for a larger population is expected to be on a rise in near and far future. Hulless or naked barley with its excellent nutritional composition and health promoting properties holds a great promise as an excellentstaple functional food. Its use in this niche role is already on a high and expected only to increase. Within hulless barley also, there are great possibility of niche or assorted compositions of health promoting functional foods such as waxy tonon-waxy barley and low tohigh ß-glucan barley. The All-India Coordinated Wheat and Barley Improvement Programme under the aegis of Indian Council of Agricultural Research has developed many high yielding and disease resistant hulless barley varieties for different production conditions (Table 2), which can be used for commercial cultivation for large scale availability of its grain as functional food.

Table1. Barley nutritional composition (100 g):

Energy	352 kcal
Carbohydrates	77.7 g
Sugars	0.8 g
Dietary fiber	15.6 g
Fat	1.2 g
Protein	9.9 g
Thiamine (Vitamin B1)	0.2 mg
Riboflavin (Vitamin B2)	0.1 mg
Niacin (Vitamin B3)	4.6 mg
Pantothenic acid (Vitamin B5)	0.3 mg
Pyridoxin (Vitamin B6)	0.3 mg
Folate: (Vitamin B9)	23 µg

(Source: USDA)

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Performance of Electronic National Agricultural Market (e-NAM) in India

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Rede G. D.[1], Ingle S. G.[1]
[1]Teaching Associate, Department of Agricultural Economics, College of Agriculture, VNMKV, Parbhani, (M.S.).

Abstract
The main purpose of this article is to highlight the performance of e-NAM in India. According to the present study it is reported that the highest number of mandis are found in Rajasthan state followed by Uttar Pradesh and Gujarat whereas lowest in Chandigarh. Highest number of registered farmers were in Uttar Pradesh while Chandigarh has the lowest number of registered farmers on e-NAM platform. Similarly in number of registered traders were again highest in Uttar Pradesh. Then the highest number of registered Commission agents were in the state Haryana and main registered FPOs were reported in Maharashtra. Lastly the maximum number of commodities traded in India is fruits and vegetables followed by food grains through e-NAM platform.

Introduction
The Union Budget 2014–15 proposed the idea of a unified common market platform, launched on 14th April, 2016, a Pan-India electronic trading portal known as National Agricultural Market (e-NAM). It is a virtual market platform linking the existing physical Mandis i.e., APMCs electronically with a theme of "one nation, one market" as eNAM market (Dey Kushankur 2016). The objective of remunerative prices for farmers by plugging the extensive trade malpractices in mandis. It is managed by Small Farmers' Agribusiness Consortium (SFAC) under the Department of Agriculture, Cooperation and Farmers' Welfare. It links agricultural produce market committees (APMCs) across all states with online trading of commodities. While the farmer is the primary stakeholder, e-NAM also provides traders, commission agents and exporters with better business opportunities through a unified and extensive market place. It aims to help them discover better prices and facilitates for smooth marketing of the products through mobile and web applications (Reddy and Mehjabeen, 2019).

This is done by providing information and services related to agri-commodities:
1. The commodities that are available in various mandis along with their prices
2. The historical prices of various commodities
3. Buy and sell trade offers for these commodities
4. Through the aforementioned information, e-NAM helps farmers bargain a better return for their produce.
5. The traders and farmers should register themselves with the portal to have access to its services.

Present Status of e-NAM Platform Linked Markets (Mandis) in India
With the aim of encouraging consistency in Agricultural Marketing in India, 1,000 Mandis have been incorporated across 18 states and 2 Union Territories. The details of Mandis roofed under e-NAM are represented in the table 1 and figure 1. There are a total 1000 e-NAM mandis across 21 States & UTs. In these mandis highest number are found in Rajasthan (144) followed by Uttar Pradesh (125) and Gujarat (122) while lowest in Chandigarh (1) (Kumar *et. al*., 2019).

Table 1. e-NAM platform linked markets (mandis) in India:

State	e-NAM mandis	State	e-NAM mandis
Andhra Pradesh	33	Maharashtra	118
Chandigarh	1	Odisha	41
Chhattisgarh	14	Punjab	37
Gujarat	122	Pondicherry	2

Haryana	81	Rajasthan	144
Himachal	19	Tamil Nadu	63
Jammu	2	Telangana	57
Jharkhand	19	Utrakhand	16
Karnataka	2	Uttar Pradesh	125
Kerala	6	West Bengal	18
Madhya Pradesh	80	Total	1000

Source: https://e-NAM.gov.in/NAM/home/mandis.html.

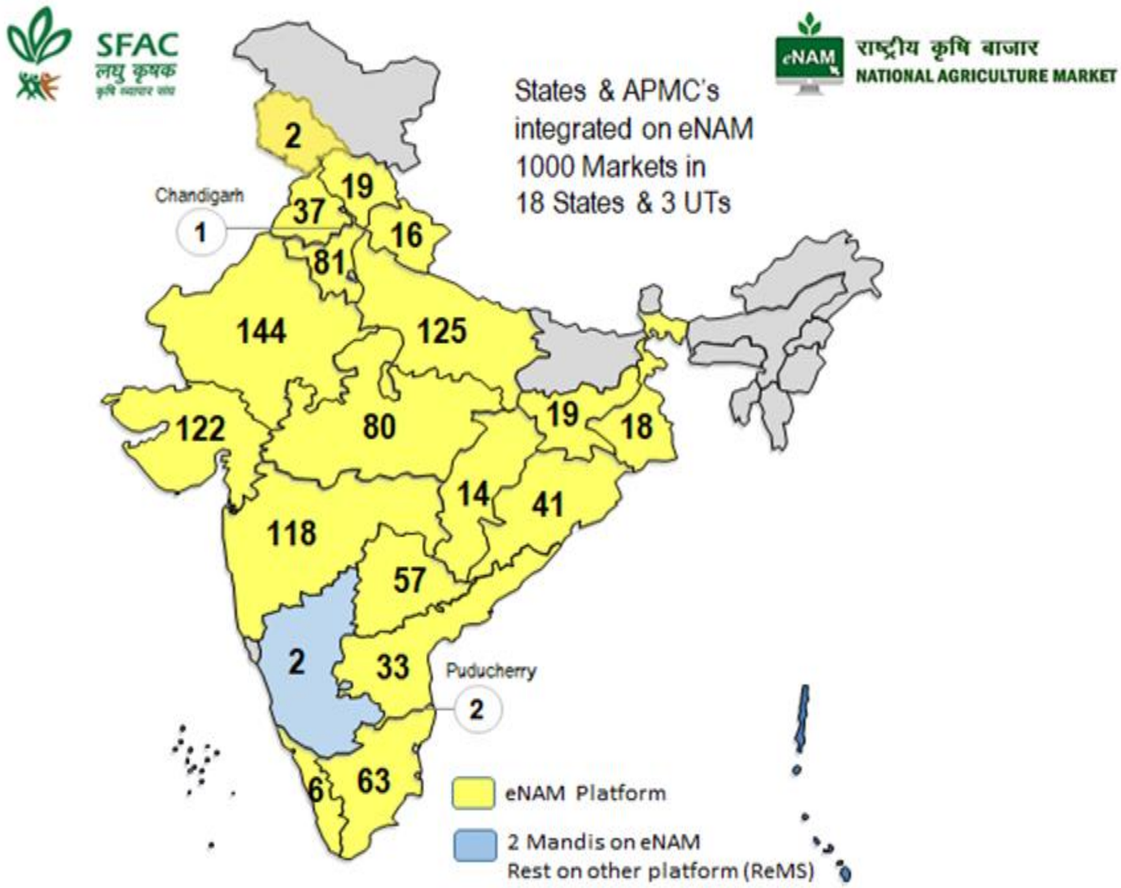

Fig. 1: e-NAM Coverage states in India | Source: https://e-NAM.gov.in/NAM/home/mandis.html

State Wise Status of Registered e-NAM Stakeholders in India

The number of the stakeholders registered on e-NAM is reported in Table 2. There are a total 166.4 lac farmers, 137359 traders 78304 commission agents and 1398 FPOs registered across 21 States of India. Highest number of registered farmers were in Uttar Pradesh (32.98 lakh) followed by Madhya Pradesh (30.12 lakh) and Haryana (27.18 lakh) while Chandigarh (0.07 lakh) has the lowest number of registered farmers on e-NAM platform. Number of registered traders were again highest in Uttar Pradesh (34055) followed by Madhya Pradesh (21093) and Haryana (10933). Highest number of registered Commission agents were in the state Haryana (22406) followed by Maharashtra (14369) and Uttar Pradesh (8509). Main registered FPOs were reported in Maharashtra (240) followed by Uttar Pradesh (168) and Andhra Pradesh (128).

Table 2: State wise status of registered e-NAM stakeholders in India:

State	Farmers (Lacs)	Traders	Commission agents	FPOs
Andhra Pradesh	14.34	3172	2253	128
Chandigarh	0.07	64	59	0
Chhattisgarh	1.35	3046	227	16
Gujarat	8.65	9193	6726	68

Haryana	27.18	10933	22406	84
Himachal Pradesh	1.21	1943	1099	49
Jammu & Kashmir	1.99	1931	783	0
Jharkhand	1.99	1931	0	48
Madhya Pradesh	30.12	21093	0	52
Maharashtra	11.64	17662	14369	240
Odisha	0.65	1635	0	81
Puducherry	0.13	138	0	0
Punjab	2.12	1748	6979	3
Rajasthan	13.08	14754	7670	128
Tamil Nadu	2.08	2623	4	93
Telangana	18.16	5645	4621	54
Uttar Pradesh	32.98	34055	8509	168
Uttarakhand	0.54	4650	2590	28
West Bengal	0.18	2476	96	114
India	**166.4**	**137359**	**78304**	**1398**

Source: https://e-NAM.gov.in.

Number of Commodities Traded through e-NAM in India and Haryana

The number of the commodities traded through e-NAM is stated in Table 3. As we can observe in India there are 150 commodities which are traded through e-NAM. Out of those vegetables and fruits (40 and 29) are found to be maximum number of commodities traded in India. Subsequently about 25 food grains/cereals are traded.

Table 3. Commodities covered under e-NAM in India:

Commodities group	Total Number
Food grains/cereals	25
Spices	14
Oil seeds	13
Vegetables	40
Fruits	29
Others	29
Total	**150**

Source: https://e-NAM.gov.in/web/commodity/commodity-list.

New Updates in e-NAM

National Agriculture Market (e-NAM) has recently been updated with two new software so that farmers need not have to travel a long distance to sell their harvest. Through the new updates, the farmers will be able to access buyers through the mobile software from the nearest warehouses and will be able to connect to the e-NAM from their own collection centres. Currently, e- NAM faces several issues due to both the lack of cooperation from the local governments and parties involved and also due to the limitations in the availability of supportive infrastructures.

Conclusion

As e-NAM has a vast prospective to rise the farmer's income and protect the farmers from exploitation by middlemen. To realize this, it is necessary to undertake reforms to ensure transparency and cost-efficiency of the mechanism is achieved. As e-NAM Portal helps in providing an online single window service in all aspects like commodity arrivals & prices, buy & sell trade offers, provision to respond to trade offers etc. It can reduce costs of transaction and helps in overcoming information asymmetry. It also helps in scientific price discovery through increased participation of traders across the country.

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Quantitative Trait Locus (QTL) Mapping

Article ID: 35012

Varsha Kumari[1]

[1]Assistant Professor, Department of Plant Breeding and Genetics, SKN College of Agriculture, Jobner-303329, Jaipur, Rajasthan.

Introduction

Quantitative characters have been a major area of study in genetics for over a century, as they are a common feature of natural variation in populations of all eukaryotes, including crop plants. For most of the period up to 1980, the study of quantitative traits has involved statistical techniques based on means, variances and covariances of relatives. These studied provided a conceptual base for partitioning the total phenotypic variance into genetic and environmental variances, and further analyzing the genetic variance in terms of additive, dominance and epistatic effects. From this information, it became feasible to estimate the heritability of the trait and predict the response of the trait to selection. It was also possible to estimate the minimum number of genes that controlled the trait of interest. However, little was known about what these genes were, where they are located, and how they controlled the trait(s), apart from the fact that for any given trait, there were several such genes segregating in a Mendelian fashion in any given population, and in most cases their effects were approximately additive (Li *et al*., 2008). These genes were termed 'polygenes' by Mather in year 1949 (Tanksley, 1993). We now refer the polygenes by a catchier acronym, 'QTL' (Quantitative Trait Loci).

What is QTL?

QTL stands for quantitative trait locus. It raises even more questions. What is a quantitative trait? What is a locus?

1. A locus is simply a region within a genome.
2. A quantitative trait is one where different individual vary continuously (like height or weight) rather than falling into discrete categories (like whether a person has blue or brown eyes).

The term QTL was first coined by Gelderman in year 1975. A QTL is defined as "a region of the genome that is associated with an effect on a quantitative trait" or a region in DNA that affects a quantitative trait. Conceptually, a QTL can be a single gene, or it may be a cluster of linked genes that affect the trait. These QTLs are often found on different chromosomes (Daniel *et al*., 2020).

What is Mapping?

Mapping means placing the markers in order, indicating the relative genetic distances between them, and assigning them to their linkage groups on the basis of recombination values from all pairwise combinations between the markers.

Principle of QTL Mapping

It is not difficult in populations of most crop plants to identify and map a good number of segregating markers (10 to 50) per chromosome. However, most of these markers would be in non-coding regions of the genome and might not affect the trait of interest directly; but, a few of these markers might be linked to genomic regions (QTLs) that do influence the trait of interest. Where such linkage occurs, the marker locus and the QTL will cosegregate. Therefore, the basic principle of determining whether a QTL is linked to a marker is to partition the mapping population into different genotypic classes based on genotypes at the marker locus, and the apply correlative statistics to determine whether the individuals of one genotype differ significantly with the individuals of other genotype with respect to the trait being measured. Situations where genes fail to segregate independently are said to display "linkage disequilibrium". QTL analysis, thus, depends on linkage disequilibrium (Collard *et al*., 2005). With natural populations, consistent association between QTL and marker genotype will not usually exist, except in a very rare situation where the marker is completely linked to the QTL. Therefore, QTL analysis is usually undertaken in segregating mapping populations, such as F_2- derived populations, recombinant inbred lines (RILs), near-isogenic lines (NILs), doubled haploid lines (DHs), and backcross populations.

Objectives of QTL Mapping

The vast majority of molecular marker research in quantitative traits has been devoted to mapping QTL. These experiments basically have the following major objectives:

1. To identify the regions of the genome those, affect the trait of interest.
2. To analyze the effect of the QTL on the trait:
   a. How much of the variation for the trait is caused by a specific region?
   b. What is the gene action associated with the QTL (additive effect? dominant effect?)
   c. Which allele is associated with the favorable effect?

Salient Requirements for QTL Mapping

1. A suitable mapping population generated from phenotypically contrasting parents
2. A saturated linkage map based on molecular markers
3. Reliable phenotypic screening of mapping population
4. Appropriate statistical packages to analyze the genotypic information in combination with phenotypic information for QTL detection.

Random-mating populations are more difficult for QTL mapping, because linkage disequilibrium is a key to detecting QTLs with markers. It is essential to develop a suitable experimental mapping population using parental lines that are highly contrasting phenotypically for the target trait (ex., highly resistant and susceptible lines). Another important requirement is that these parental lines should be genetically divergent. The basic purpose of QTL mapping would be largely served if one can detect the QTLs with major effects. This would require, in general, a mapping population of a size of 200-300 individuals. To perform a whole-genome QTL scan, it is desirable to have a saturated marker map. In such a map, markers are available for each chromosome from one end to the other, and adjacent markers are spaced sufficiently close that recombination events only rarely occur between them. For practical purposes, this is generally considered to be less than 10 recombinations per 100 meioses, or a map distance of less than 10 centiMorgans (cM). In the model plant *Arabidopsis thaliana*, which has a particularly small genome, this requires as few as 50 markers.

The target quantitative traits have to be measured as precisely as possible and limited amounts of missing data can be tolerated (Manly *et al*., 2001). Data is typically pooled over locations and replications to obtain a single quantitative trait value for the line. It is also preferable to measure the target trait(s) in experiments conducted in multiple (and appropriate) locations to have a better understanding of the QTL x environment interaction, if any.

The basic objective in QTL mapping studies is to detect QTL. Tests for QTL/trait association are often performed by the following approaches:

a. Single Marker Approach or Single Factor ANOVA.
b. Simple Interval Mapping (SIM).
c. Composite Interval Mapping (CIM).
d. Multiple Interval Mapping (MIM).

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Special Horticulture Practices in Banana

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Bhadke T. G.[1]

[1]Ph. D Scholar, Department of Horticulture, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri- 413722 Maharashtra.

Introduction

Banana is an important staple and a source of income for small holding growers of the tropical humid lowlands to dry mild subtropics of India. The fact that, banana fruits throughout the year add to its importance as a food security crop. However, the productivity and lifespan of banana has drastically reduced due to lack of proper scientific cultivation. Banana being a significant food crop, it has greater economic importance among the food crops, since it is one of the leading commodities in agricultural exports. Hence, the production performance of the crop is of critical importance in improving the efficient use of resources. To achieve higher yield requires skills, dedication, and following proper cultural approaches. The following special operations directly affect the productivity and quality of banana.

High Density Planting

To increase the productivity per unit area, it is advisable to go for high density planting. Besides higher yield, it helps reduce labour cost and increase the efficiency of utilization of inputs such as fertilizers and water. The population is increased by adjusting the row to row spacing and planting more than one sucker per hill.

Desuckering

It involves the removal of unwanted suckers and it is practiced periodically once in 45 days, otherwise they compete with the mother plant for nutrients resulting in lower bunch weight and yield.

Propping

In case of taller varieties like Poovan, Monthan, Robusta etc. Forked branches or bamboo poles are given as support to the bunch to avoid damage due to overweight and strong wind.

Mulching

Mulching is useful in conserving the soil moisture increasing the number of feeder roots and thereby improving the nutrient and water use efficiency suppression of weed growth and thereby increase banana yield by 30-40%.

Earthing Up

It is important which provides support to the base of the plant. Earthing up should be done at the rainy season for avoiding water logged conditions. It will also provide proper drainage facility to the plant.

Bagging or Bunch Covering

Bagging of bunches with perforated polythene bags or blue plastic bags or dry leaves is practised to protect the fruits against cold, sunburn, insect, pest and bird attack as well as to develop attractive uniform finger colour. The right stage of bunch covering is when the last hand has opened and the male bud has to be removed at that time.

Removal of Withered Styles and Perianth

Removal of dead leaves is practiced to reduce disease spread to prevent senescent leaves from hanging over suckers and reducing light and to prevent fruit scarring.

Denavelling

Removal of male bud after completion of female phase is referred to as denavelling. It helps in saving the movement of nutrients to unwanted sink and promote finger size which ultimately increases the bunch weight. The excised male bud is also used as vegetable.

Bunch Thinning

One or two small bottom hands should be removed from the bunch in order to facilitate uniform bunch development. Keep only 7-8 hands.

Mattocking

After harvest of crop, the plant stem should be cut in stages to facilitate resyphoning of the nutrients from the mother corm to the developing ratoon crop plant.

Conclusion

Banana cultivation is very profitable and viable agribusiness if planned well. Therefore, in banana, the above special horticulture practices can be a strategy for further increasing the yield, quality, quantity, weight of fruits so that growers can get high and profitable price to their produce, this practices also has one beneficial effect that without using any chemical we can enhance yield and mange over banana orchard. These approaches need to be strengthened through knowledge extension to farmers to enhance their adoption in a big way.

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Indian White Shrimp an Alternate to *Litopenaeus vannamei*

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Samrat Kumar Nirala[1]
[1]B.F.sc., 4th yr., Dr. R. P. C. A. U, Pusa.

Introduction

India is moving forward towards the self-dependence in every sector but somehow, we are still reliant on exotic species for Shrimp farming which is the biggest thorn in the development of India. A lion's share of shrimp production is coming from *L. vannamie* but still we don't have brooders for the seed production, for that we have to import the brood stock from the other countries for that we need a huge investment which cannot be afforded by our small-scale farmers.

For them Indian white shrimp (*Penius. indicus)* can be a better alternative, as Indian white shrimp is a native species to India, found all around the Indian coasts and its management is comparatively simpler than the *vannamie* because it has adapted to this environment very well.

Why to Choose Indian White Shrimp?

Avoidance of quarantine measures: Most of the brooders of *vannamie* get imported from other countries, from where it can carry multiple types of disease in our country which can devastate the Indian fisheries so, before introducing it into the farm it needs to be quarantined for some period of time which need great maintenance with huge investments.

But Indian white shrimp can solve this problem because it is native to India; we don't need to import it from any other country because it is found in good quantity in Indian coastal water and also according to research it has been proven that Indian white shrimp is not a carrier of many of diseases.

Abundance of stock: This covid pandemic has taught a lesson that over dependence on other country can destroy you anytime, Reports show that because of the lockdown around 78% of Indian hatchery operators were in loss due to the 30 to 40% decline in the import of *vannamie* seed and around 27% of Indian farmers were ready with their prepared pond for the stocking but due of lack of quality and quantity of seed they became unable to stock and they faced a heavy loss in their production, Covid pandemic is still spreading their legs, so Indian farmers should take lesson and move towards the potential species which India is having in a good quantity.

Penius indicus is one of that potential species. four distinct genetic population of *Penius indicus* has been recognised in India and it indicates the potential for genetically distinct population. Indian white shrimp is found all over the coast of India and its breeding is quite easy. Said by Mr. Panigrahi.

Adaptive to Wide range of fluctuations: Indian white shrimp may show greater tolerance and better growth than Vannamie because it is native to India and has adapted to this environment. it could be cultivated in high saline and high temperature condition because it is a strong osmoregulator. it can tolerate a temperature range of 18 to 34.5 degrees Celsius and salinities of 5 to 50 PPT.

Easy production of Specific Pathogen free stock: *Penius indicus* is not a natural host of many emerging diseases so, it would be relatively easy to develop disease free in our budget, on the other hand *vannamie* is highly susceptible and a career of many diseases such as Taura syndrome virus (TSV), white spot syndrome virus (WSSV) Yellow head virus (YHV), Infectious hematopoietic necrosis virus (IHHNV) and Lymphoid organ vacuolization virus (LOVV). Specific pathogen free stock of *vannamie* charges a big amount which cannot be afforded by small scale farmers, so for them Indian white shrimp can be a better alternative.

Nutritional value: As aquaculture is more focused in the production of surplus amount of protein for that Indian white shrimp can be a better option because its protein content is 52.8% whereas *vannamei* only contains 39.8 % of its total dry body weight. Indian white shrimp is also rich in carbohydrates, it contains 13 % of total dry body weight whereas *vannamie* only contains 4.8 %.

Suitable species for Polyculture: Indian white shrimp can also be cultured in polyculture system. In this system Indian white shrimp get cultured with milk fish; According to research if we culturing Indian white shrimp with milk fish, we can get a better growth rate, less microbial load and a maintained good water quality. Researcher fount this technique very profitable and ecofriendly.

How *P. indicus* can be an Alternative of *L. vannamei*?

Intensification: According to FAO in India intensive culture of *P. indicus* is not in practice but if it gets included in our practice it would be a benison for the Indian fisheries. Because of its intensification, we can get a huge augment in our production. According to FAO article; through intensification we can get 10000-20000 kg/ha/yr.

By intensification we can also secure our shrimp stock from the WSSV because intensification is all about proper management & maintaining the optimal condition. According to research it was found that WSSV out broke because only of the unbalanced water parameters. Low dissolved oxygen & high ammonia concentration in water & sudden change in Temperature, pH & salinity might lead to considerable stress, and these stresses make the fish susceptible to WSSV infection in these traditional ponds, therefore intensification is a better solution for this.

Domestication & selective breeding of *P. indicus:* Introduction of exotic species can cause adverse impact on the environment. These impacts involve habitat destruction, introduction to pets & pathogen and can also compete with native species for food and space and displacement. Therefore, a lot of government agencies have taken keen interest in the development of native species as signatory of biodiversity. Even many stakeholders are concerned on overdependence on exotic *p. vannamei* culture in India. In this condition Indian white shrimp is found to be better alternative to the development of SPF stock for shrimp culture in India.

Reproduction under captivity is the most important criteria for domestication and selective breeding, *P. indicus* can easily breed under captivity. Breeding technology of indicus has been standardized. Growth and production performance of indicus is better the domesticated *vannamei*. For ex. Indian white shrimp can attain 18.4g within 114 days at SD @30shrimp/m^2, whereas *vannamei* attain the same result in 147 days at low S.D. @12 shrimp/m^2.

Establishing hatcheries: Some hatcheries were established in late 1980s, but at commercial level, it is yet to be developed. Till now most of the Indian hatchery operator imports brooders of *vannamei* from other country for seed production which is not feasible and that's make the shrimp farming more expensive, but Indian white shrimp can solve all these problems because its stock is abundantly found all over the Indian water and its brooders can be captured easily. Seed production and breeding of Indian white shrimp is quite easy and can also be bred in captive.

Eye stalk ablation is the most common technique for the maturation of shrimps which causes death of many brooders, which leads to the shortage of brooders but *P. indicus* can mature and spawn in captivity without eye stalk ablation by keeping the light intensity below 500lux and feeding with fresh clam meat and oligochaetes and keeping pH between 8-8.2, therefore its brooders can be bred again and again.

Conclusion

Over dependence on exotic species can devastate the Indian fisheries at any time so we should divert our focus towards the potential species which is found in India abundantly. Indian white shrimp is one of that species, which has been scientifically proven as a better alternative to *vannamie*. Quarantine measures can be avoided in its production because it is not get imported from other countries. Researches have proven that Indian white shrimp is not a carrier of n numbers of diseases and also not susceptible to them and also easy to develop a disease-free stock. Nutritionally it better than *vannamie* and also a suitable species for the polyculture. Intensification, domestication, selective breeding and hatcheries establishment of Indian white shrimp can help in the augmentation of shrimp production in India.

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Environmental Sustainability and Development- Building a Better Tomorrow

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Mugdha Samantaray[1]

[1]Postgraduate diploma in Environmental and sustainable development, Indira Gandhi National Open University.

Ours is the age of science. No other label would do. It is not simply that there have been momentous scientific discoveries and inventions adding to the comfort of life, but at what cost. The world today has descended into a deep pandemonium. There goes a famous adage by HENRY DAVID THOREAU "What is the use of a house of you don't have a decent planet to pit it on?" The statement clearly indicates that the current scenario of the planet. Globalisation and industrialisation have brought along a new gamut of opportunities and perks but the lavish lifestyles in return have raised an alarming effect on our environment.

Sustainable development is a common agenda for global concern, which everybody agrees upon. So, what is **Sustainable Development**?

The most accepted definition of sustainable development according to the **Brutndtland's report** is to meet the needs of present without compromising the ability of future generations. The concept applies to a healthy economic, ecological, and social system for human development.

Pillars of Sustainable Development?

1. **Economic Sustainability**: This implies a system of production that satisfies present consumption without compromising future needs.
2. **Social Sustainability**: This encompasses notions of equity, empowerment, accessibility, participation, cultural identity and institutional stability.
3. **Environmental Sustainability**: It relates to ecosystem integrity and carrying capacity of natural environment.

What is Environmental Sustainability?

According to the UNITED NATIONS(UN) WORLD COMMISSION ON ENVIROMENT AND DEVELOPMENT, environmental sustainability involves behaving in such a manner that we are sure later generations have natural resources for their use. It is crucial for them to lead a life as good as or better than we do now.

Importance of Environmental Sustainability

It involves responsibly engaging with the Earth and managing natural resources. We should not endanger the capacity for later generations to sustain themselves.

Ways to Promote Environmental Sustainability

1. **Recycle:** Purchasing goods from recycled material and recycling products has long term benefits. Recycling reduces pressure on raw materials, minimizes fuel, and mining and other costs. These are costs of processing, extracting and transporting minerals. Crucial landfill space is also saved.

2. **Grow a garden**: The food bought from market undergoes a process (growing, storing and transporting). The food at a grocery store does not always undergo sustainable techniques. One can decrease carbon footprint and negative environmental influence by producing crop in one's own backyard.

3. **Reduce:** Waste-Around 50% of the food materials is wasted while marketing, transporting and packaging and doesn't reach the customer. One should consider the resources and energy wasted while distributing, storing and producing food.

4. Buy energy efficient appliances: Switch old appliances with energy efficient ones. Their cost is recovered with time. Energy efficient appliances have better insulation and save on energy.

5. Use public transportation or carpool frequently: Travelling by public transportation or carpooling frequently decreases carbon emissions by private cars and reduces transportation cost.

6. Plantation drive: Increased tree plantation improves the society, environment and economy. Trees make the air better. They counter greenhouse effects, decrease the pressure on cooling and heating.

Companies Adopting Environmental Sustainability

1. COCA-COLA: In 2018 the company announced its world without waste initiative.
2. LEVIS: Reduce water consumption used in the manufacturing and production of jeans.
3. IKEA: Circular economy target 2030 which means that the products can be reused and recycled.
4. LEGO: Focus on less plastic use. Aims to use more sustainable products for the manufacturing of its products.
5. Amazon: Overall goal to reach net 0 carbon emissions by 2040.
6. WALLMART: Aims to reduce global emissions by 2040.
7. APPLE: Commits to be 100% carbon neutral for its supply chain and production by 2030.
8. ADIDAS: Targets to manufacture shoes by using ocean wastes.

Environmental and sustainability and its developmental is truly the need of the hour. It is thus one of the biggest challenges and the most important targets of the present times. Environmental sustainability is the key strategy against the backdrop of growth of human population and the rampant exploitation of environment by humans. Therefore, it is our most important responsibility to leave the planet as a self-sustainable system providing equal opportunities of survival not only to our future generations but also to all other species co-habiting with us. By doing our bits and contributing even a fraction amount we can make this planet a better place to live in.

Aloe Vera: Importance, Cultivation and Used in Folk Medicine

Article ID: 35016

Shiwanand Pandey[1]
[1]Research Scholar, Sardar Vallabhbhai Patel University of Agriculture and Technology Modipuram Meerut, Uttar Pradesh 250110.

Introduction

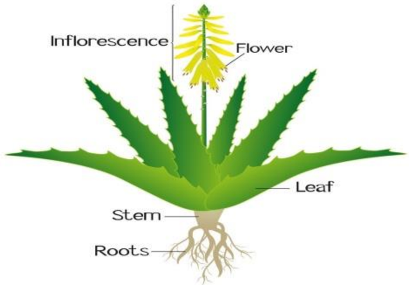
Aloe Vera is referred as the "Miracle Plant" and also known as "wand of heaven" by the native Americans. From being an antiseptic, anti- inflammatory and a cure for heart burns to helping relieve the symptoms of severe illnesses like cancer and diabetes, to being a beauty aid and nourishes health, this ancient Indian herb has it all. Known for centuries for its unique medicinal properties, it has been rediscovered, recognized and for its health benefits.

Aloe Vera is as old as civilization and throughout history it has been used as a popular folk medicine. It is believed to be effective in treating stomach ailments, gastrointestinal problems, skin diseases, constipation, for radiation injury, for its anti-inflammatory effect, for wound healing and burns, as an anti-ulcer and diabetes. It is also known as "lily of the desert", the "plant of immortality", and the medicine plant with qualities to serve as alternate medicine. Aloe is grown USA, Mexico, India, South America, Central America, Australia and Africa.

It is commonly called Miracle plant, Healing plant, Plant of immortality, Fountain of youth. Aloe species are frequently cultivated as ornamental plants both in gardens and in pots being highly decorative. The botanical name of Aloe Vera is (*Aloe barbadensis* Mill), (*Aloe vera* (L.) Burm.) belong to family aloeaceae, the common name in English aloe vera and indian aloe, in Hindi ghritkumari, gwar-patha in Sanskrit Kumari, in Tamil kattalai, in Kannada kathaligidi, in Telgu kalabanda, in Malayalam kattuvala in Marathi korafad in Bangla kumara in Gujarti Kunwar in Arabic mussavar and in Chinese -: 芦荟.

Aloe is a stem less or very short-stemmed succulent plant growing to 80-100 cm tall, spreading by offsets and root sprouts. The leaves are lanceolate, thick and fleshy, green to gray-green, with a serrated margin. The flowers are produced on a spike up to 90 cm tall, each flower pendulous, with a yellow tubular corolla 2-3 cm long Its thick leaves contain the water supply for the plant to survive long periods of drought. These leaves have a high capacity of retaining the water. When a leaf is cut, an orange yellow sap drips from the open end which has a very strong laxative effect.

When the green skin of a leaf is removed a clear mucilaginous substance appears that contain fibers, water and the ingredients to retain the water in the leaf. These ingredients give this "gel" its special qualities as they are known now for many centuries. Among the uses for this gel is acceleration of wound healing, use on skin burns, moisturizing dry skin and it is taken internally for peptic ulcers or gastritis. Aloe vera plant has the ability to survive for long periods without water. The Aloe Vera plant has double the photosynthetic properties of other plants. Because of this, it needs more exposure to sunlight than regular plants. It has thick layers around the leaves that protect it from drying out. Constant sun exposure is a very important when growing Aloe Vera. Aloe Vera is a succulent, and as such, stores a large quantity of water within its leaves and root system. The Aloe Vera root is very thin. The plant likes to search for water.



Origin and Distribution of Aloe-Vera?

Ancient records of the Egyptians, Arab, African, Asians and Americans have discussed the different uses and pathological cases in which Aloes were administered. Aloe was cultivated in Egypt thousands of years ago and was used by the people of the Mediterranean at least 400 years before Christ. Aloe is also mentioned in the Bible's New Testament. Aloe was also mentioned in ancient Chinese transcripts. It was employed medicinally for eczematous skin conditions in China and India under the name Luhui in China and Musabbar in India. The Greeks knew Aloe through the Indians. The Greek physician Peter Pedanius Dioscoriades wrote about Aloe in his medicinal plant collection materna medica. Aloe was first illustrated in the Codex Aniciae Julianae which was written around the year 512 A.D. by Dichotomous. Aloe was also mentioned in the writings of the Latin writer, Aurelius Celsus, who wrote a book about medicine and called it De Medicina, which appeared for the first time in the year 1378. In America, Aloe was mentioned in Columbus journals.

There have been mentions of the Aloe plant in the Rig Veda, which is the earliest book of natural medicine dating BCE 4,500 and BCE 1,600. In Rig Veda, Aloe Vera is specifically recommended for the reproductive system, liver and dealing with worms when injected or consumed. External uses included healing of wounds." A complete detail about its medicinal uses was also found in Papyrus ebers, an Egyptian document written in BCE 1,550. There were around 12 formulae given in this book to mix the Aloe Vera gel with other agents to solve skin and internal disorders. The early Egyptians revered aloe and called it the 'Plant of Immortality.

Aloe Species

Aloe vera belongs to the family Liliacae and nearly there are about 150 species in Aloe vera. The common varieties are: *Aloe Barbadensis* Miller, *Aloe Saponaria*, *Aloe Chinensis*, *Aloe Variegata*, *Aloe Forex*, *Aloe Lalifolia* and *Curacao Aloe*.

Chemical Constituents and Nutritional Value

Aloe contains two classes of Aloins: (1) nataloins, which yield picric and oxalic acids with nitric acid, and do not give a red coloration with nitric acid; and (2) barbaloins, which yield aloetic acid ($C_7H_2N_3O_5$), chrysammic acid ($C_7H_2N_2O_6$), picric and oxalic acids with nitric acid, being reddened by the acid. Major chemical constituents of Aloe Vera Gel consist primarily of water and polysaccharides (pectins, hemicelluloses, glucomannan, acemannan, and mannose derivatives). It also contains amino acids, lipids, sterols (lupeol, campesterol, and β-sitosterol), tannins, and enzymes. Mannose 6-phosphate is a major sugar component. Aloe Vera contains 19 of the 20 amino acids required by the human body and 7 of the 8 essential amino acids (that the body cannot make), Aloe Vera contains also contain useful enzymes like Amylase, Bradykinase, Catalase, Cellulase, Lipase, Oxidase, Alkaline Phosphatase, Proteolytiase, Creatine Phosphokinase, Carboxypeptidase. Most of these are beneficial to human metabolism.

Aloe Vera contains many vitamins including A, C, E, folic acid, choline, B1, B2, B3 (niacin), B6. Aloe Vera is also one of the few plants that contain vitamin B12. Some of the 20 minerals found in Aloe Vera as: calcium, magnesium, zinc, chromium, selenium, sodium, iron, potassium, copper, manganese. Aloe vera plant is also known as "lily of the desert", the plant of immortality, and the medicine plant with qualities to serve as alternate medicine. Aloe vera is commonly used in many cosmetic products and the rise of natural and organic beauty may constitute a new opportunity for this plant.

Aloe gel, found inside the fleshy leaves, works as a topical treatment by hydrating the skin and forming a protective barrier. This gel is 99 percent water with loads of amino acids, lipids and sterols. In fact, the National Center for Biotechnology Information uses all the buzzwords we look for in pricey skin care products to describe its benefits: collagen-building, antioxidant, anti-inflammatory, moisturizing and anti-aging.

Aloe is one of the most widely-used ingredients in high-grade skin care products. Aloe soothes the skin, hydrates it, nourishes it, and accelerates the regeneration of new skin tissue. (In fact, simply removing the gel from a living aloe vera leaf and placing the raw gel on your face is far superior to even the most expensive eye cream or skin care product on the market. Aloe also enhances skin health when used internally. The outer skin of the Aloe Vera plant - often called CAPE ALOE - is a strongly laxative herb. It is also very, bitter and unpleasant in taste and used only occasionally.

Cultivation

Aloe Vera is relatively easy to care for in cultivation in frost-free climates. The species requires well-drained sandy potting soil in moderate light. If planted in pot or other containers ensure sufficient drainage with drainage holes. The use of a good quality commercial potting mix to which extra perlite, granite grit, and coarse sand are added is recommended. Alternatively, pre-packaged 'cacti and succulent mixes' may also be used. Potted plants should be allowed to completely dry prior to re-watering. During winter, Aloe may become dormant, during which little moisture is required. In areas that receive frost or snow the species is best kept indoors or in heated glasshouses.

Climate and Soil

Aloe Vera is grown in warm tropical areas and cannot survive freezing temperatures. Hot climate suits the growth of Aloe Vera plants. Growing Aloe Vera plants in warm climates make them flourish and widely spread. During the winter months, the plant will become somewhat dormant. During this period watering should be minimal, allowing the soil to become completely dry. Aloe Vera can be cultivated on any soil for 'dry land management', sandy loamy soil is the best suited for it. The soil should be moderately fertile and fast draining as Aloe Vera plant itself contains lot of water and it will wilt if the soil is not fast draining.

Manures and Fertilizers

The crop responds well to the application of farm yard manure and compost. During the first year of plantation, FYM @20 t/ha is applied at the time of land preparation and the same is continued in subsequent years. Besides vermicompost @2.5 tonnes/ha can also be applied.

Propagation

Aloe Vera is generally propagated by root suckers by carefully digging out without damaging the parent plant and planting it in the main field. It can also be propagated through rhizome cuttings by digging out the rhizomes after the harvest of the crop and making them into 5-6 cm length cuttings with a minimum of 2-3 nodes on them. Then they are rooted in specially prepared sand beds or containers. The plant is ready for transplanting after the appearance of the first sprouts. The process of cultivating Aloe Vera involves the following process. The ground is to be carefully prepared to keep free from weeds and the soil is ideally kept ideally slightly acidic. The soil should be supplied supplement in the form of ammonium nitrate every year. The plants are set spaced out by 31 inches in rows and between the rows. At that rate, about 5,000 plants are set per acre. An 8 - 12-inch aloe pop would take about 18 - 24 months to fully mature. The plants, in a year's time, would bear flowers that are bright yellow in colour. The leaves are 1 to 2 feet long and are cut without causing damage to the plant, so that it lasts for several years.

Harvest Aloe Vera Gel

Cut a mature leaf from the plant use a sharp knife or garden shears to cut it at the plant's base slice the leaf in half lengthwise cut along the aloe leaf's length to reveal the thick green or clear gel inside. squeeze the leaf over a bowl, forcing the aloe gel out of the leaf and into your container. Aloe vera in an airtight container in the refrigerator for up to seven days. You can also place aloe vera in an ice cube tray and freeze it for up to a year.

Plant Protection

Diseases:

a. Anthracnose disease *Colletotrichum gloeosporioides:* The initial appearance of small round to oval, dark green water-soaked which later become circular spots with tan to light brown center. As the spots mature the center of the lesion become reddish brown to brown color. With progress in disease the lesions join together to form big necrotic area. Disease is favored by warm, wet weather, spread easily during wet weather by water splash. Disease controlled by application of suitable fungicides.

b. Basal stem rot *Fusarium spp.:* Plant bas turning reddish brown to black and rotting disease emergence favors cold, damp conditions. Diseased can successfully controlled by *p*ieces of plant may be saved by taking cuttings above rotted portion.

c. Bacterial soft rot *Pectobacterium chrysanthemi:* Plant become watery, rotting leaves which are darker in color, young leaves wilting and collapsing leaves bulging due to gas formation inside. Bacteria survive in plant debris in the field, disease emergence favored by hot, wet weather. Disease can be avoided through controlling over-watering plants.

Insects- Pests:

Aloe vera aphid *Aloephagus myersi:* One of important quarantine pest both adults and nymphs feed at the bases of the leaves or in rolled ends of damaged leaves. They also secrete honeydew which is resulting in sooty mold development. Severe infestation leads to slow growth and stunting. Organically acceptable methods of control include the application of insecticidal soap and preservation of natural enemies.

Advanced Practices in Asparagus

Article ID: 35017

Rajesh Choudhary[1], Murari Lal Chopra[1], Mahaveer Prasad Ola[2]
[1]Ph.D. Scholar, Department of Horticulture, Sri Karan Narendra Agriculture University, Jobner-303328.
[2]Ph.D. Scholar, Department of Plant Breeding and Genetics, Sri Karan Narendra Agriculture University, Jobner-303328.

Introduction

Asparagus consisting of 300 species is a large genus belongs to liliaceae family, of which native to India. It is cool season crops, hardy, dioecious vegetable. Its plants are erect under shrubs, rarely herbs. Root stocks are stout, creeping, sometimes bearing tubers In India, two species of asparagus namely *Asparagus officinalis* L. and A. racemos are most commonly cultivated. Asparagus is cultivated for the tender shoots, commonly known as spears, which has an agreeable flavor after it has been boiled. It is a long-time crop because (i) it is grown for about 2 years before it is cut in quantity and (ii) with good care it yields well for 10-12 years. Some plants might live longer, but when a large percentage become weak it is wise to discard the crop. There is a gradual increase in yield usually for 6- 8 years after planting, yield is maintained upto about the twelfth year, after which the yield declines gradually. The best quality yield was obtained from the fourth to tenth year.

Asparagus officinalis L.: It is known as Halgun, Halyun, Hillua and shatawar and it is cultivated for its tender shoots.

Botany

Asparagus is perennial, dioecious herb with erect branched stem growing 1 to 3m tall. The underground part consists of rhizomes or the crowns and their lateral extensions, fleshy and fibrous roots. The buds are borne on the crowns, arranged in compact order on the upper surfaces. The aerial stems arise from a bud on the rhizomes, which constitute the edible spears, arise from the previous year on the rhizomes. The fleshy roots arise from the crowns and may spread widely and deeply. They continue to elongate for 2-4 years and function chiefly as storage organs and slightly as absorbers; they store the food that is made in the leaves and stems, and give this up to the shoots in spring. New fleshy roots arise each year behind the terminal buds of the rhizomes and replace the old fleshy roots that die. Fibrous roots arise from fleshy roots in great profusion. Flowers are white, fragrant, and 2-2.5 mm longe fruit is a three lobed, red coloured berry, up to 5 mm in diameter. Flowering and fruiting occur in December-January.

Uses

It is used as vegetable and also eaten green. The spears are treated as a delicacy in preparation of soup and other vegetable products. Large quantities of asparagus spears are canned and frozen. It is considered to be a good diuretic and is used especially in cardiac dropsy and chronic gout.

Suitable Varieties

Perfection: It is early, spears large, green, succulent, heavy cropper and uniform in maturity.

Mary Washington: These are most important varieties and produce very high yield. It is the oldest variety which may be regarded as the form from which all the modern types have been derived.

White German: It has rounded tips and good quality spears.

Palmetto: It has a little difference in appearance than other varieties and considerably resistant to rust.

Jersey Queen: A clone cultivar selected from Mary Washington. It produces high quality spear and maximum yield.

Lucullas 1883 and Limbrass 126 are the best white type cultivars.

Hybrids: HD-INDIA, Gijnlim, Revolution, Lara and Mira, and Faribo.

Field Preparation

1. Deep ploughing up to 20-25cm followed by 2-3 harrowing Seed Rate and Spacing.
2. 3-4kg of seeds is required to raise seedling for planting in one hectare.
3. 70-75cm×50cm spacing required for transplanting the crop from nursery.
4. Seeds when transplanted through crown 1 year old crown of good health is selected and transplanted in furrows at 45-60cm spacing within rows.
5. 30000 plants/ha is desirable 70 cm×50cm spacing required for transplanting the crop from nursery.

Manures and Fertilizers

A yield of 20 quintals of asparagus removes 44 kg of nitrogen, 13.5 kg of phosphorus and 40kg of potash. It is therefore, necessary to add about 50-65kg of nitrogen, 20 kg of phosphorus and 55 kg of potash every year in two splits; first dose during early spring before the growth starts and the second when harvesting is completed.

Irrigation

Irrigation is a continuing operation to obtain high yield. The irrigation is given by means of flooding as per soil and climatic conditions. The first irrigation is given at the time of planting and thereafter, at 10-12 days interval.

Intercultural Operation

Asparagus is a perennial vegetable crop and hence requires different form of interculture. Hoeing should be done carefully in the crop to avoid any injury to the roots. It is desirable to disk and harrow thoroughly and apply fertilizers before growth starts. These operations should be done every year.

Blanching

Blanching is normally done to produce white asparagus.

Mulching

It is found that mulching in asparagus bed is beneficial to control the weeds, to maintain the soil moisture, soil temperature, for better growth and higher early yield.

Weed Control

The weed control for asparagus is to be taken in timely and more attention should be given than other vegetable crops.

Harvesting

Harvesting should be done after 2 years of planting. The cutting should be limited to 2-4 weeks in first cutting and spears are cut off below the ground surface with a knife.

Yield

Average yield per year is 5-10 q/ha.

Insect Pests

Asparagus beetle (*Crioceris asparagi*)
Control spray malathion @ 0.1%.

Disease

Asparagus rust.
Control (Spray Dithane M-45).

Watershed Development for Rural Livelihood

Article ID: 35018

G. Thiyagarajan[1]
[1]Water Technology Centre, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu (641 003), India.

Introduction

Watershed is also nomenclatured as drainage basin, catchment or drainage area, refers to the area drained by a stream in such a way that all flow originating in that area is discharged through a single outlet.

The watershed management implies, the judicious use of all the resources *i.e.,* land, vegetation and water of the watershed to achieve maximum production with minimum hazard to the natural resources and for the well-being of the people. The task of watershed management includes the treatment of land by using most suitable biological and engineering measures in such a manner that, the management work must be economical and socially acceptable.

Soil and Water Conservation

1. These measures are aimed at improving soil moisture availability and surface water availability for supplemental irrigation.
2. Conservation measures in arable lands can be broadly divided in to two categories: permanent and temporary.

Contour Bunds

Contour bunding consists of building earthen embankment at intervals across the slope and along the contour line of the field. A series of such bund divide the area into strips and act as barrier to the flow of water. As a result, the amount and velocity of run-off are reduced, resulting reducing the soil erosion. Contour bunding is made on land where the slope is not very steep and the soil is fairly permeable. Contour bunds are also called level terraces, absorption type terraces or ridge type teracces.

	
Contour bunds	**Bench Terraces**

Bench Terracing

A terrace is an embankment of ridge of earth constructed across the slope to control run off and to minimize soil erosion. A terrace reduces the length of the hill side slope, thereby reducing sheet and rill erosion and prevents formation of gullies. It consists of transforming relatively steeps land into a series of level or nearly level strips or steeps running across the slope.

The soil materials that are excavated from the upper part of the terrace is used in filling the lower part and a small bund is also raised along the outer edge of the terrace to check the downward flow of rainwater and also soil erosion.

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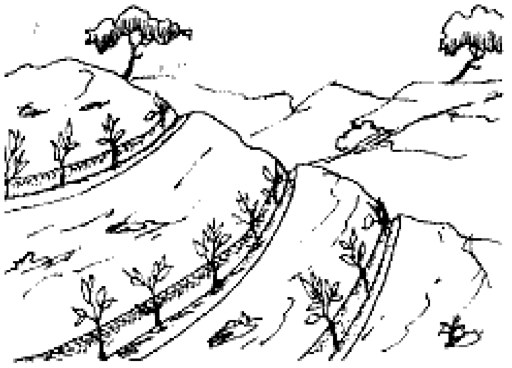
Contour Trenching

It consists of making a series of deep pit (i.e., 2ft. wide and 1ft. deep) or trenches across the slope at convenient distance. The soil excavated from the trenches is deposited on the lower edge of the trenches where forest trees are planted.



Contour trenching

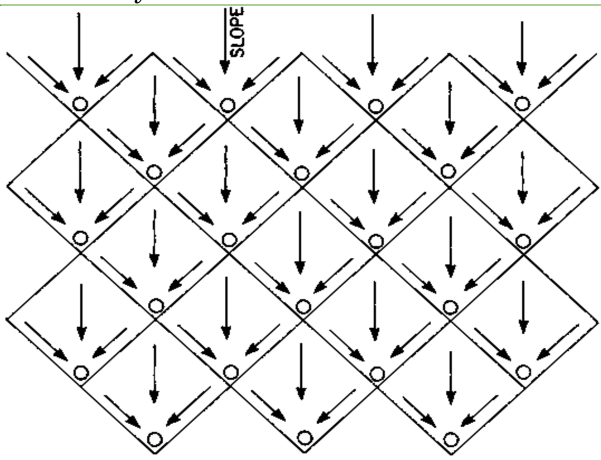
Compartmental bunding

Compartmental Bunding

Areas having a slope of 1% or less are suitable for compartmental bunding. It helps in accumulation of more water and a uniform spread of water in the entire area. Levelling is also done with nominal or no additional expenditure.

Micro Catchments

Micro catchments are diamond-shaped basins surrounded by small earth bunds with an infiltration pit in the lowest corner of each. Runoff is collected from within the basin and stored in the infiltration pit. Microcatchments are mainly used for growing trees or bushes. This technique is appropriate for small-scale tree planting in any area which has a moisture deficit. Besides harvesting water for the trees, it simultaneously conserves soil. Microcatchments are neat and precise, and relatively easy to construct.



Micro catchments

Strip Cropping

Strip Cropping

It consists of growing erosion permitting crop (e.g., Jowar, Bajra, Maize etc.) in alternate strips with erosion checking close growing crops (e.g., grasses, pulses etc.). Strip cropping employs several good farming practices including crop rotation, contour cultivation, proper tillage, stubbles mulching, cover cropping etc. It is very effective and practical means for controlling soil erosion, especially for gently sloping land.

Contour Stone Bund

Contour stone bunds are used to slow down and filter runoff, thereby increasing infiltration and capturing sediment. The water and sediment harvested lead directly to improved crop performance. This technique is well suited to small scale application on farmer's fields and, given an adequate supply of stones, can be implemented quickly and cheaply.

	
Contour stone bund	**Check dams**

Check Dams

This may be a temporary structure constructed with locally available materials. The various types are: Brush wood dam, loose rock dam and woven wire dam. The main function of the check dam is to impede the soil and water removed from the watershed. This structure is cheap, but lasts about 2-5 years. The cost of the structure depends on the materials used, the size of the gully and the height of the obstruction (dam). A permanent check dam can be constructed using stones, bricks and cement. Small earth work is also needed on both sides. A little water is also stored above the dam. This water recharges the groundwater.

Conclusion

By following the above-mentioned techniques, the watershed may be management effectively and developmental activities in the watershed can be achieved for the betterment of rural livelihood.

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Medicinal Mushrooms for Prevention of Human Diseases

Article ID: 35019

Anamita Sen[1]
[1]Ph.D scholar, Plant Pathology, PG College of Agriculture, Dr. RPCAU, PUSA, Bihar.

Introduction

Mushrooms are fleshy macroscopic fruiting bodies or sporocarps produced by fungi belonging to Basidiomycetes and Ascomycetes. These comprise a large, heterogenous group having various shapes, size, color, appearance and edibility. More than 69,000 different species of mushrooms have been recorded so far of which 2000 are known to be edible. Mushrooms have a long history of use; its consumption is increasing even in the developing world, due to their good contents of proteins and minerals. Mushrooms have also been reported as therapeutic foods, useful in preventing diseases such as hypercholesterolemia, hypertension and cancer. These functional characteristics are mainly due to their chemical composition. In general mushroom fruiting bodies on dry weight basis contain about 39.9 % carbohydrate, 17.5 % protein and 2.9 % fat and rest being the minerals. Historically, the larger fungi, the mushrooms, have had a long and successful medicinal use especially in traditional Chinese clinical medicine for many forms of immune disorders. At present the main products submitted for clinical testing include Lentinan from *Lentinus edodes* fruit-bodies, Schizophyllan from Schizophyllum. PSK and PSP, from mycelial cultures of *Trametes versicolor* and Grifron-D from fruit-bodies of *Grifola frondosa*.

Important Medicinal Mushrooms and their Benefits

1. Chaga (*Inonotuus obliquus*): Chaga has been used by traditional cultures for its health benefits, for hundreds of years. It grows high up on the bark of brich trees in the Eastern U.S. and Canada. Chaga's most important components betulinic acid and melano-glucan complexes are derived from the bark from the birch trees the fungus grows on.

Benefits of Chaga:

a. Prevents cancer: Chaga is rich in antioxidants, which are chemicals that help prevent cell damage caused by free radicals or oxidants. When the body is unable to produce enough antioxidants to prevent this damage, oxidative stress occurs. Oxidative stress can cause cancer and a host of other health problems. It was found that triterpenes, the compounds found in chaga and some other mushrooms, cause tumor cells to self-destruct. Unlike other cancer treatments, however, chaga does not appear to harm healthy cells.

b. Anti inflammation: Chaga promotes the formation of beneficial cytokines (specialized proteins that regulates immune system) thus stimulates WBC which are essential for fighting off harmful bacteria.

c. Lowering blood sugar: A study revealed that chaga mushrooms could lower blood sugar in rats. The rodents were genetically modified to have diabetes and to be obese. After eating chaga mushrooms for 8 weeks, their blood sugar levels were lower. Though no research has been done on humans yet, this suggests that chaga might contribute to an alternative treatment for diabetes in the future.

2. Reishi *(Ganoderma lucidum)*: Reishi is also known as the mushroom of long life. The Reishi mushroom contains several bioactive compounds. These compounds include specific polysaccharides, with triterpene being one of the active polysaccharide compounds of Reishi mushroom. It is a polypore shelf mushroom, ranging in color from orange-white during development to the glossy red of its mature stage.

Benefits of Reishi:

a. Anti-aging Properties: 25% ethanol extract of *Ganoderma lucidum* expands life span. Reishi Polysaccharide factor 3, GlP 1,2,3,4 are components which possess antiaging properties.

b. Anti-cancer Potential: Most people consume reishi mushrooms due to their anti-cancer properties. The triterpenoids found in this type of fungus has the ability to reduce the metastasis of cancerous cells and slow the progression of tumor growth. Improved Cognitive Activity.

c. Prevents allergy: For those suffering from asthma, bronchitis or other chronic respiratory conditions, reishi mushroom extract can have a strong effect on reducing irritation and eliminating the allergic reactions from the body. By preventing the release of histamine from mast cells in the body, reishi mushrooms prevent allergic reactions, from mild skin irritation to potentially life-threatening anaphylaxis.

3. Shiitake (*Lentinula edodes*): For hundreds of years, shiitake mushrooms have been a popular food source in Asia. They're the second most popular and the third most widely cultivated edible mushroom in the world. shiitake mushrooms have antiviral, antibacterial and antifungal properties. They also help to control blood sugar levels and reduce inflammation within the body.

Benefits of Shiitake:

a. Fight against Obesity: Certain components of the shiitake mushroom have hypolipidaemic (fat-reducing) effects, such as eritadenine and b-glucan. Studies have reported that b-glucan can increase satiety, reduce food intake, delay nutrition absorption and reduce plasma lipid (fat) levels. The researchers concluded by suggesting that shiitake mushrooms can help prevent body weight gain, fat deposition and plasma triacylglycerol when added to a high-fat diet.

b. Destroy Cancer Cells: A study published in the *Journal of Alternative and Complementary Medicine* investigated the potential roles of an ethyl acetate fraction from shiitake mushrooms. The study involved two human breast carcinoma cell lines, one human nonmalignant breast epithelial cell line and two myeloma cell lines. The results suggest that shiitake mushrooms were able to inhibit growth of tumor cells

c. Support Cardiovascular Health: Shiitake mushrooms have sterol compounds that interfere with the production of cholesterol in the liver. They also contain potent phyto nutrients that help keep cells from sticking to blood vessel walls and forming plaque buildup, which maintains healthy blood pressure and improves circulation.

d. Promote Skin Health: When selenium is taken with vitamins A and E, it can help reduce the severity of acne and the scarring that can occur afterward. A hundred grams of shiitake mushrooms contain 5.7 milligrams of selenium, which is 8 percent of your daily value. That means shiitake mushrooms act as a natural acne treatment.

4. Turkey Tails *(Coriolus versicolor)*: *Coriolus versicolor* ("multicolored mushroom") also known as *Trametes versicolor*, is a mushroom readily found in woodlands in China and Europe. It grows in clusters or tiers on fallen hardwood trees and branches, frequently in large colonies It has a thin, velvety fruiting body, usually 2- 7 cm wide, fans out into wavy rosettes, giving rise to its popular name, Turkey Tails.

a. Aids in digestion: Contains Prebiotics (fibre) which helps in growth of beneficial bacteria such as *Acidophilus, Bifidobacterium.*

b. Prevents AIDS: In the year 2005, it was reported that mushroom extracts PSP inhibits replication of HIV.

c. Strengthen immune system: PSK is the best-known active compound found in Turkey tail mushroom which helps to repaor damaged cells and also strengthen immune system.

5. *Cordyceps sinensis:* *Cordyceps* have a large variety of medicinal effects and Chinese practitioners have used them as medicine for hundreds of years. *Cordyceps* grow on bat moth larvae, at a specific time of year in the high altitudes of Tibet. and have a symbiotic relationship with their host.

Benefits:

a. Anti-Cancer Properties: Cordyceps are a source of very beneficial bioactive compounds which according to a study conducted in the year 2015 are able to decrease cell proliferation and induce apoptosis in lung cancer cell lines by activating P53 gene. One study suggests that cordyceps help in reversing the side effects of cancer therapy like Leukopenia.

b. Improves kidney health: Although the exact chemical pathway of this is unclear, studies have shown that kidneys health improve notably after one month of regular Cordyceps.

6. Maitake (*Grifola frondosa*): The "hen of the woods" is a culinary delight, with a subtle flavor and great texture. They are commonly found in clusters at the base of maple, oak or elm trees and can grow to over 100 pounds, earning them the title "king of the mushrooms."

In recent years, several promising studies have researched the potential connection between the maitake mushroom and cancer. Although more research is needed, some studies suggest that maitake mushrooms could help naturally lower cholesterol levels to keep our heart healthy. An animal model published in the *Journal of Oleo Science*, for example, found that supplementation with maitake a mushroom was effective in reducing cholesterol levels in mice. Some research suggests that maitake mushrooms may be therapeutic against PCOS and could help combat common issues like infertility.

7. *Pleurotus spp*: This genus, also known as oyster mushrooms, has approximately 40 species (all are commonly edible and available). In addition to their nutritional value, they possess medicinal properties and other beneficial effects and health-promoting effects.

Pleurotus pulmonarius demonstrated an anti-inflammatory response in rats with colitis, and *P. ostreatus* inhibited leukocyte migration to acetic acid-injured tissues. An extract from P. florida suppressed inflammation. Water-soluble polysaccharides extracted from *P. tuber-regium* (scelrotial mushroom) a novel edible mushroom, showed effective antiproliferative activity against human leukemia cells and induced apoptosis in HL-60 cells. The aqueous and ethanolic extracts from *P. giganteus* have shown antioxidant, genotoxic, and liver protective properties.

		
Inonotuus obliquus	**Cordyceps sinensis**	**Grifola frondosa**
		
Lentinula edodes	**Coriolus versicolor**	**Ganoderma lucidum**

Conclusion

Even though much importance is given to medicinal plants in India by policy makers, so far not much attention has been paid to medicinal mushrooms. However, traditionally people are using mushrooms to treat various illnesses like use of white *polypores* to treat ear infection (Andaman) and *Ganoderma* for mumps (northern parts of Kerala). Most of these medicinal mushrooms are being cultivated on sawdust/ wood chips/ wheat straw/paddy straw.

In India, these raw materials are available in plenty. India produces about 600 million tons of crop residues/year. The temperature and humidity are the major factors which affect mushroom production. Mushroom cultivation is labor intensive and it gives high returns/ unit area. These factors are highly suitable for Indian conditions and medicinal mushrooms fetch more returns in the market. However, at present India imports medicinal mushrooms from countries like Malaysia.

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Floating Agriculture: Climate Resilient Strategy for Waterlogged Areas

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Priyanka Bora[1], Priyanka Dutta[2]
[1]PhD student, Assam Agricultural University, Jorhat.
[2]Subject Matter Specialist (Agronomy), KVK, Sivasagar.

Introduction

Floating agriculture was an indigenous soilless farming system practiced in flood affected areas or water-logged areas where no other crop production practices were possible. This technique was widely practiced for thousands of years before the adaptation of modern agriculture, dominantly in the areas of Meso-America and South East Asia. With the advent of modern agriculture, the popularity of this technique slowly became narrower. But now time has changed. Climate change is a reality of today's world and India is becoming vulnerable to extreme floods as a consequence of it. In India, out of 329 mha, 40 mha is flood prone area i.e., 12% of total geographical area of the country (Ministry of Home Affairs, Govt. of India, 2015). During 2017-19, India lost 18 million hectare cropped area which is 8.5 % of total gross cropped area due to flood and this is affecting newer areas that were not flood-prone earlier (Kapil, 2021). Farmers are becoming helpless due to extreme weather fluctuations. So, it's high time to adopt such technologies which will help us to cope with changing climate as well as maintain sustainability without compromising the crop yield.

Floating agriculture is a technique of growing crop in agricultural land which remains waterlogged for longer periods due to extreme flood. Scientifically floating agriculture may be referred to as hydroponics where plants are grown on water on a floating bed. In this technique, firstly bamboo beds are constructed with an average size of 20 ft x 5 ft x 1 ft and floated on the water bodies. At the bottom layer water hyacinth or other aquatic plants are intertwined to form a mesh, above this a 5-inch layer of a mixture of silt, vermicompost and farm yard manure are applied. The top layer is packed with 3-inch mixture of dry leaves of leguminous plants, soil and silt where crops are grown. The farmers generally use small country boats for sowing, weeding, harvesting and carrying the products. The vegetables (bottle gourd, pumpkin, wax gourd, beetroot, cabbage cauliflower, chilli, okra, tomato, spinach, amaranthus, coriander, lettuce, water spinach, fish mint, vegetable mustard, melons etc.) are mainly grown through this technique and in some parts paddy is also cultivated.

Advantages

1. Agricultural advantage:

a. Best alternative for crop production in water logged areas.

b. The essential raw materials like water hyacinth, other aquatic plants are easily found on water bodies.
c. This technique reduces the application of chemical fertilizers, pesticides and eliminates the cost of irrigation.
d. The rafts can be moved from place to place.
e. The maintenance and management cost are minimal.
f. The productivity of floating agriculture is higher as compared to land-based cultivation practices.

2. Ecological advantages:

a. This technique restores a healthy water ecosystem by utilizing water hyacinth as raw material without use of any chemical fertilizer or pesticides.
b. It recycles water hyacinth which also helps to clean water-bodies.
c. This innovative technology does not produce any byproduct which may harm environment and can have a positive impact on biodiversity conservations.
d. This is one of the alternative solutions to sustainable agriculture.

3. Socio-economic advantages:

a. This technique could help the farmers to grow crops in flood affected area and stabilize their income during the lean period.
b. Farmers will able to meet their household needs, nutrition and food security.
c. It creates job opportunities and promotes economic status of farmers.

Conclusion

Floating agriculture is an environment friendly traditional system. In the vision of sustainable livelihoods and refining climate change strategies, this innovative technology can be adopted as a low-tech production system with almost no use of chemicals. So, this technique could be a sustainable and profitable practice in flood-prone areas of India. Public awareness is one of the options to introduce this practice among the farmers of flood affected areas as well as in the whole country.

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Nano-Fertilizers Use in Vegetable Crops

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Rajesh Choudhary[1], Murari Lal Chopra[1], Mahaveer Prasad Ola[2]
[1]Ph.D. Scholar, Department of Horticulture, Sri Karan Narendra Agriculture University, Jobner-303328.
[2]Ph.D. Scholar, Department of Plant Breeding and Genetics, Sri Karan Narendra Agriculture University, Jobner-303328.

Introduction

Fertilizers are chemical compounds applied to plant to promote growth and yield. The artificially synthesized inorganic fertilizers are used for a plant with appropriate concentration, and the fertilizer usually supplies Nitrogen, Phosphorus, and potassium (N, P, and K) as the three main nutrients for various crops and growing conditions shows some important application of nanotechnology in the agriculture sector.

Nano-fertilizer is a substance that can hold a great number of nutrients, slow and steady release purposes. It facilitates the uptake of nutrients matching the crop necessity level without any toxicity of customized fertilizer inputs.

Nano-fertilizers are nutrient carriers developed using substrates with 1-100 nm nano dimensions of that can supply single nutrient or in combination to enhance plant growth, performance and yield. Though they do not directly provide nutrients to crops still they have better performance when compared to conventional fertilizers.

Nano-fertilizer is any product synthesized with nanoparticles or nanotechnology by enriching nutrients to the adsorbents to enhance performance of nutrients and improve plant nutrition compared to traditional fertilizers. Extensive surface area of nanoparticles accomplishes them to hold nutrients abundantly and release nutrients deliberately to meet the requirements of crop without any adverse outcome. Nanoporous materials or nanotubes can be exploited for encapsulating nano-fertilizers by coating with lean defensive polymer film derived as emulsion or particles of nanoscale dimension.

Plant nano-nutrition: Plant nano-nutrition includes the use of nanoparticles- ZnO, SiO2, iron oxide, Cu, Mn oxide, nano-fertilizers- phosphorus, nitrogen or nano-nutrient for providing essential nutrients to plants for growth, development and productivity. Nutrient source for the plant is through nano-nutrients or nano-fertilizers applied. The nutrients are released deliberately in a regulated manner to meet the crop requirements for better nutrient use efficiency.

There are some other potential ways to design nano – fertilizer for crop production, Slow-release fertilizer the nanocapsule slowly releases nutrients over a specified period quick-release fertilizer the nanoparticle shell breaks upon contact with a surface (such as striking a leaf). Specific release fertilizer: the shell breaks open when it encounters a specific chemical or enzyme. Moisture release fertilizer: the nanoparticle degrades and releases nutrients in the presence of water. Heat release fertilizer: the nanoparticle releases nutrients when the temperature exceeds a set point. pH release fertilizer the nanoparticle only degrades in specified acid or alkaline conditions. Ultrasound release the nanoparticle is ruptured by an external ultrasound frequency. Magnetic release: a magnetic nanoparticle ruptures when exposed to a magnetic field.

Nitrogen-Based and Utilization Efficiency (NUE)

The Attempts taken to increase the NUE in conventional fertilizer formulations have not been much effective. Nanotechnology-based nitrogen fertilizers will be more effective than even polymer-coated conventional slow-release N fertilizers. In research, the release of nitrogen by urea hydrolysis has controlled through the insertion of urease enzymes into nanoporous silica. The nitrogen sometimes makes lost in the environment. It is not utilizable by crops, which causes large economic and resource losses and is instrumental to very serious environmental pollution. If the problem should reduce, some properties should be noted in the fertilizer, such as applying an adequate amount of fertilizer, deep placement of fertilizer, use of granular Urea, improving crop response knowledge, and using slow-release nano fertilizer. The nitrogen is getting from the urea because it is a rich source of nitrogen nanoparticles as a fertilizer Nitrogen is well known as the most important nutrient available for plant growth.

Phosphorus Nano Fertilizer

Second major nutrient for the plant is phosphorus (P). There are some fertilizers such as TSP (triple superphosphate, (NH3H2PO4), DAP diammonium phosphate, MAP (mono ammonium phosphate, are commercially available water-soluble phosphate salts. There is a huge problem in human, while the P entre into the water. Therefore, remediation technology has been proposed to reduce P fertilizer application and prevent the applied P from entering into water bodies [28]. Therefore, the nanotechnology surface functionalization of P will change the chemical properties and which will be brought down the mobility in the soil and bioavailability of the algae. The synthesis of phosphorus-based nano-fertilizer as a conventional fertilizer for agricultural purposes, would enhance agronomic production, use efficiency of P, and improve the surface-water quality.

Nano Silica as a Fertilizer for Plant

Silicon material is also referring between essential and nonessential substances for the plant because it is not participating in the survival of most plants, but in the cause of different environmental stress conditions, the plants can adapt and get benefits in the presence of silica. Therefore, it is worth to study the way Si nanoparticles behave in the agricultural system. The role of silicon dioxide nanofertilizer in the cucumber (*Cucumis sativus L.*) plant shows increasing plant height, number of leaves, number of fruits (fruit weight) and also the foliar spray of SiO2 improve growth parameter of cucumber once compare with untreated [34]. Nano silica particles absorbed by roots will enhance the plant's resistance to stress and improve yields because the absorbed silica forms films around the cell walls of the plant.

Zinc Oxide Nanoparticles as a Fertilizer

The ZnO (Inorganic sources of Zn) is the most commonly used Zn fertilizer that is applied to the crops in Zn-deficient regions. The application of ZnO nanoparticles into fertilizers as a source of Zn might be a promising approach that can proceed novel solubility option of ZnO NPs to improve the efficiency of Zn fertilizers. Further, the application of Zno NPs as a source of Zn in Zn fertilizers may improve the efficiency of the fertilizer and Zn availability to plants by enhancing the rate and extent of Zn dissolution. The Zn NPs may be applied as a foliar spray for the plant to improve the functions. This treatment may potentially enhance uptake and the penetration of zinc oxide nanoparticles in the plant leaves.

Copper Oxide Nanoparticles as a Fertilizer

Copper oxide nanoparticles show a positive effect on germination but are phytotoxic at seeding growth. However, some studies have been evaluating the potential of copper nanoparticles in crop growth. Visualizing enormous beneficial aspects of metal nanoparticles shows the possible role copper nanoparticles can play in enhancing growth and increasing the yield of plants.

Uses in Vegetable Crops

Potato cv. Arizona, fertilizer use efficiency and agronomic use efficiency could be increased by fertigation with nano NPK fertilizers Tomato yielded highest number of fruits per plant, fruit weight, fruit diameter by application of 300 kg/ha Nano fertilizer, and the highest plant height and stem diameter was observed under application of 400 kg/ha K nano fertilizer. Application of Ferbanat nanotechnology liquid fertilizers @ 3 L/ha to cucumber crop gave highest fruit diameter.

Application of Nanonat @ 3.0 L/ ha to Cucumber crop gives highest TSS applied bio-organic nano- fertilizers prepared from cattle manure at a dose of 0.5 or 1 litre/ha at beginning of intensive sugar beet development (BBCH 18 and BBCH 37-38) singly or doubly. It was observed that all treatments improved photosynthesis process and productivity of sugar beet.

Compared to control plants 1 L/ha dose increased leaves number by 19.6 %, leaf area by 13.4 %, diameter of root by 11.1 %, canopy dry mass by 29.1 %, root biomass by 42.6 %, net photosynthetic productivity by 15.8 %, root yield by 12.6 %, sucrose content by 1.03 % and white sugar yield increased by 19.2 %. Nor et al. (2017) studied the effect of nano- fertilizer NPK 20:20:20 at 4, 8, 12 kg/ha and commercial single fertilizer NPK 34:56:56 kg/ha as soil application on dwarfed long bean. All the treatments showed increase in chlorophyll content and number of leaves.

Conclusion

Nanotechnology is one of the most tremendous tools in modern agriculture products that provide nutrition, protect plants, monitor plant growth, and detect diseases. The article explores useful information about Nanoscale fertilizers currently used to crop production and how they affect a positive way to improve production than the conventional fertilizer. The use of nanotechnology in fertilizer provides such wonderful benefits, such as three times increase in Nutrient Use Efficiency (NUE), 80 – 100 times less requirement for chemical fertilizers.

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Utilization of Bumble Bees in Crops Pollination

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Manoj Kumar[1], Jat Lomash Kumar[1], Sunita Yadav[1]
[1]Department of Entomology, College of Agriculture, CCS, Haryana Agricultural University, Hisar (Haryana).

The bumble bees play important role in the production of seeds and fruits of cultivated as well as wild flora by way of pollinating the flowers. The pollination effectiveness of bumble bees makes them important pollinators of specific plant species. A very little attention was paid in India in respect of biology, nest architecture, nesting habitat, domestication of bumble bees and utilization of laboratory reared bumble bees in pollination of crops. This article discusses shortly about peculiarities of bumble bee in respect to pollination of crops. Bumble bees are a group of conspicuous, large and colorful bees that mainly inhabitant cold and temperate habitats at high latitudes and elevations. They belong to order Hymenoptera, family Apidae, tribe Bombini and genus Bombus having more than 250 species in temperate, sub-temperate and sub-tropical regions (Williams *et al*. 2008). The prevalent and readily recognized bumble bees are big and furry corbiculates (i.e., they have soft regions on the hind legs surrounded by stiff bristles for transporting pollens) with no hindwing jugal lobe. Based on difference in size and coloration, there are several bumble bee species viz., *Bombus haemorrhoidalis, B. waltoni, B. himalayanus, B. asiaticus, B. rufofasciatus, B. tunicatus, B. trifasciatus, B. keriensis* etc. in distinct areas of Himachal Pradesh, in India (Saini *et al*. 2012).

Introduction

The bumble bee (Bombus spp.) comprises a group of several hundred species found primarily in temperate regions. Bumble bees are highly social, like honeybees, but with smaller, less structured nests, consisting of one to five hundred bees. Bumble bees work harder, faster, and at cooler temperatures than honey bees. Bumble bees play a vital role in pollination of plants. Bumble bees are important pollinators of crops and native plants. Bumble bees are excellent pollinators of a wide variety of crops although in some plant species they cut a hole in the base of the corolla and "rob" the nectar without effecting pollination. Red clover is an excellent forage crop for bumble bees as it provides forage plants that bloom eight to nine weeks. The bumble bees pollinate tomatoes, eggplants, peppers, melons, raspberries, blackberries, strawberries, blueberries and cranberries.

The genus Bombus comprising 239 known species the world over and *B. mendacibombus* reported in west Himalayan, Pakistan and Kashmir. Rearing of bumble bees and their utilization in pollinating crops grown in poly houses has taken the shape of industry in western world. In India very little attention was paid in respect of their biology, nest architecture, nesting habitat, domestication of bumble bee colonies artificially and utilization of laboratory reared bumble bees in pollination of crops. The pollination effectiveness of bumble bees makes them important pollinators of specific plant species in this way. The bumble bees play important role in the production of seeds and fruits of cultivated as well as wild flora. Recently, several species of Bombus have been managed in laboratories with the aim to use for pollination of greenhouses tomato in Europe.

Utilization of Bumble Bees as Effective Pollinator

1. The bumble bee is capable of vibrating the flower using the unique "buzz pollination" mechanism. A bumble bee provides a backup pollinator and capable to pollinate crops effectively than other modes of pollination.

2. The bumble bee is less affected by extreme weather conditions than the honey bee. Bumble bees are cool weather operators. Unlike honey bees, bumble bees are active at low temperatures (5°C), in windy conditions and under cloudy skies.

3. The bumble bee is better adapted to perform under confined greenhouse conditions. Bumble bees are not only excellent pollinators in open air, but are especially valuable in greenhouses and plastic tunnels.

4. Many species have longer tongued than honeybees, so they can pollinate flowers with long, narrow corollas. They are very hairy and their hairs are branched and so are perfect for picking up and transferring pollen.

5. Bumble bees can completely replace manual pollination resulting in less labour costs. In crops, such as tomatoes, peppers and blue berries bumble bee pollination results in higher yield as well as larger and higher quality fruits.

Problems in Utilizing Bumble Bees as Pollinator

1. Advancement in the field of bombiculture is lacking as compared to other countries where bumble bee industry has been adopted as entrepreneurial activity and bumble bee colonies are supplied by commercial enterprises to fulfill the need of pollination.

2. Decreasing number of bumble bees due to clearance of waste lands and wild plants as major flora and nesting sites of bumble bees.

Conclusion

Nest architecture studies helps in designing artificial domiciles for bumble bees which can be efficiently utilized for pollination of various cash crops under open as well as protected conditions. Bumble bees can be utilized as a backup pollinator for honey bees as it is not infested by Varroa and other diseases known to honey bees. Bumble bee rearing should be enhanced to develop the bombiculture industry in the country or to conserve the native pollinators.

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Common Milk Adulteration: An Overview

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Dr. R.S. Khillare[1], Dr. Muskan Kaushal[2]

[1]Scientist, Department of Veterinary Public Health, Mumbai Veterinary College, Parel, Mumbai-400012.
[2]Senior Research Fellow, Department of Veterinary Public Health, Mumbai Veterinary College, Parel, Mumbai-400012.

Introduction

Milk is nature's ideal food. Milk is defined as the fresh, clean, lacteal secretion obtained by complete milking of one or more healthy animals. Due to its unique nutritional value and its important role in human and animal health, milk is very important. Milk is recommended for young and old people, because of its nutritional value (Reddy *et al.,* 2017). Milk is the excellent and cheapest source of nutrition and used by all the age groups in rural as well as in urban areas. Milk is an important food of diet of vast population on earth as well as milk is universally recognized as a complete diet due to its high nutritional value for human.

Milk is a valuable source of protein, fat, carbohydrates, vitamins and minerals. Also, along with furnishing energy giving lactose and many other essential nutrients, therefore an ideal food for pregnant female and infants. Milk is provided essential nutrients to maintain good health and normal growth of body. Adulterations of milk and dairy products have brought dangerous risk to human health as well as huge economic losses to the food industry. To keep milk temporarily fresh, some unethical methods of preservation are usually adapted to prevent the financial losses due to the spoilage of milk during its transportation and sale.

Some chemicals such as hydrogen peroxide, carbonates, bicarbonates, caustic soda and formalin to increase the shelf life of milk, detergents to enhance the cosmetic nature of milk which give foamy appearance and whitening of milk that led to gastro-intestinal health problem. Due to shortage or to meet the undersupply of milk and for their economic profit some people are preparing synthetic milk by mixing caustic soda, refined oil, urea and common detergents. Synthetic milk is harmful to human health. Many of the times, the adulteration of milk is done intentionally to make more profits, but sometimes, it may be due to the lack of awareness, lack of preservation technology, refrigeration facilities and proper modern detecting technology.

Probable reasons behind milk adulteration may be demand and supply gap, perishable characterises of milk, low purchasing capability of customer and lack of easily available suitable detection tests (Kamthania *et al.,* 2014**)**. Apart from economic and moral issue, contaminated milk can create huge human health hazards. The Government of India promulgated the 'Prevention of Food Adulteration Act' in 1954 from the point of view of protecting public health. Different type of kits and methods is used to detect adulterants in milk by using different techniques.

Some of the method/techniques for detection of milk adulterant are fluorescence of advanced maillard products and soluble tryptophan, Gas chromatography, High-performance liquid chromatography, High-performance thin-layer chromatography, Matrix-assisted laser desorption/ionization-time of flight mass spectrometry, Differential scanning calorimetry, colour capillary electrophoresis, enzyme-linked immunosorbent assay, Blot immunoassay method, Near-infrared spectroscopy, Fourier-transform infrared spectroscopy, Immunochromatographic assay, Polymerase chain reaction, urea-polyacrylamide gel electrophoresis, Biosensor assay based on surface plasmon resonance and cryoscopic method.

Common Milk Adulterants and their Health Threat on Humans

1. Water: Water is the most common adulterant into the milk. Milk is mostly diluted with water to increase the volume and quantity of milk. It reduces the nutritional value of milk. Milk adulterated with contaminated/polluted water congaing pesticides; heavy metals may cause serious health hazards to consumer. Some simple method/test for detection of milk with water can be carryout at home. The existence/presence of water can be identified by putting a drop of milk on a polished slanting surface. One drop of pure milk flows slowly leaving a white trail behind it, whereas milk adulterated with water will flow immediately without leaving a mark. Cryoscopic and lactometric methods are commonly used for the determination of water added in milk.

2. Urea: Urea is among the most commonly used milk adulterant. Urea is added to milk to increase the solid-not-fat content, to increase milk quality, to increase nonprotein nitrogen content. It also provides whiteness to milk. It is also used for to prepare synthetic milk. Drinking of urea contaminated milk leads to acidity, indigestion, ulcers in human. Urea is harmful to the heart, liver, particularly to the kidneys, because the kidneys have to do more work to extract urea from their bodies (Kandpal *et al*., 2012).

3. Sucrose/ Table sugar: Sucrose is generally added to milk to raise the density of milk. Sugar is mixed in the milk to increase the solids not fat content of milk. It increases the lactometer reading of milk, which was previously diluted with water. Lactose is the usual sugar present in milk. The fat content of the milk is more as compared to the protein content. Table sugar viz. sucrose is added to the milk to increase the carbohydrate content of the milk.

4. Starch: Starch is another common adulterant found in milk. Starch is added to make up the density of milk. Starch is one such component that is added to increase solids not fat content in milk. Starch helps to prevent the detection of extraneous water added to milk. If huge levels of starch are added to milk, the effects of undigested starch in the colon may cause diarrhoea in human body. Apart from starch, wheat flour, arrowroot and rice flours are also added into the milk.

5. Glucose: Glucose is added to increase the lactometer reading. It also provides taste. Poor quality glucose is harmful to diabetic patients in human.

6. Detergent: Detergent is added to milk to proper emulsify and dissolve the oil in water giving a frothy solution, increase the foaming of milk and therefore to have thick milk contents (Singuluri and Sukumaran, 2014). Addition of such chemicals will cause health problem in human especially related to gastrointestinal and kidneys organ. Detergent improves milk's cosmetic character. Shake 10 ml of milk sample with an equal amount of water and lather formation indicates the presence of detergent in milk.

7. Salt: Sodium Chloride commonly known as salt is added to milk to make up the density of milk to prevent the detection of added water. Drinking of milk adulterated with salt is not safe for people with high blood pressure.

8. Hydrogen Peroxide: Hydrogen Peroxide is added to milk for improving the quality of milk. It provides prolonged freshness to milk. Hydrogen peroxide badly affects gastrointestinal tracts. It may lead to gastritis and intestinal inflammation. It also disturbs the body's antioxidants, disrupting the normal mechanisms of immunity and hence increasing ageing.

9. Maltodextrin: Maltodextrin is a common additive used in milk. It increases the volume and quantity of milk and milk products. Consumption of milk adulterated with maltodextrin may cause allergy and diarrhoea in human

10. Melamine: To increase the protein content melamine is added to the milk and milk powder. It causes the Failure of kidneys.

11. Milk powder: Occasionally milk powder as an adulterant is added in fresh collected milk. This is done for economic profit when a country has milk powder either in excess or in the form of subsidy is provided for dried powder milk

12. Chlorine: Chlorine is put to compensate the density of the diluted milk after addition of water into the milk. Drinking of chlorinated milk may cause imbalance of the acid base balance in the body and also blood pH in human. It may cause clogging in arteries and develop heart problem.

13. Neutralizers: Neutralizers like alkali bicarbonates, carbonates are added to milk to neutralize the developed acidity. In synthetic milk, sodium hydroxide is often used to neutralise the acidic effect. Neutralizers are not good for human health. It causes gastrointestinal complications.

14. Preservatives: Growth and multiplication of micro-organism production spoils the milk and spoiled milk isn't safe for human health. The milk can be protected from microorganism and increase the shelf life for a long period of time by adding boric acid, formalin, sodium carbonate, sodium bicarbonate, salicylic acid, benzoic acid, sodium azides. These adulterants induce stomach pain, vomiting, diarrhoea in human.

15. Whey: The Addition of liquid-whey is a very common procedure to increase the volume of milk. Low priced and quality rennet whey is occasionally mixed with liquid milk and milk powder. Some dairy product manufacture use inexpensive muriatic acid to prepare whey, which causes severe health problems in human.

16. Low valued Milk: Milk, milk powder and other dairy products are frequently adulterated by low priced non-milk proteins such as soy, pea and soluble wheat proteins. Many times, by combining lower price valued milk with higher valued milk, milk is adulterated. Goat milk is frequently adulterated with cow milk for greater benefit. O*ccasionally* milk fat is replaced by fat from other sources which may also pose a risk to human health.

17. Food colours: Frequently several food colouring agents are added into the milk to enhance its appearance. Due to drinking of such contaminated milk leads to hazardous health effects in human.

Conclusion

Milk is an important food of diet of vast population of society. Milk is the most perishable food due to its high nutritive value and high moisture content. Adulteration in milk with common milk adulterants is a serious problem for public health concerns nowadays. Many times, banned substances are added into the milk. Consumption of lower quality adulterated milk may lead to serious human health issues. To ensure adulterant-free milk for consumption, different quality control tests for milk are a significant feature.

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Advanced Practices in Lemon Grass

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Rajesh Choudhary[1], Murari Lal Chopra[1], Mahaveer Parsad Ola[2]
[1]Ph.D. Scholar, Department of Horticulture, Sri Karan Narendra Agriculture University, Jobner-303328.
[2]Ph.D. Scholar, Department of Plant Breeding and Genetics, Sri Karan Narendra Agriculture University, Jobner-303328.

Introduction

Lemongrass is known as East Indian lemongrass and tropical perennial plant which yields aromatic oil. The name lemongrass is derived from the typical lemon-like odour of the essential oil present in the shoot. Lemongrass is good soil binding nature, so it is used for soil and conservation purpose. Oil of commerce is popularly known as Cochin oil in the world trade, since 90% of it is shipped from Cochin part. The state of Kerala in India had the monopoly in the production and export of lemongrass oil.

Cymbopogon flexuosus (2n=20, 40) It is known as East Indian, Cochin or Malabar grass. *C. flexuosus* is a tufted robust perennial grass of about 3 m height. The leaves are linear and lanceolate. It flowers freely. The inflorescence is very large and highly branched terminal drooping panicle bearing paired spikes on tertiary branches. The spikes bear spikelets in pairs of which one is sessile and the other pedicellate. The sessile spikelet is an awned bisexual floret whereas the pedicellate is an awnless staminate floret. Under this species two varieties or types are identified based on the colour of the stem.

C. flexuosus var. *flexuosus* – It is red grass. The stem and leaf sheath are reddish or purple in colour. It is recognized as the true lemongrass and is commercially cultivated (Fig. 24.1.1-3). The essential oil contains more than 75-80% citral, exhibits good solubility in alcohol and hence is superior in quality.

*Cymbopogon citratus (*2n=40, 60) It is known as West Indian or American lemongrass. It is a stemless perennial grass with numerous stiff tillers arising from short rhizomatous rootstock, making large tussocks. It seldom flowers under cultivation.

Leaf blade is narrow, glaucous, drooping with scabrous margin, ligule truncate, inflorescence rarely produced, a large loose panicle; spathe bracts long and narrow, sessile spikelets, awnless, linear, lanceolate. The essential oil contains 74-76% citral and exhibits poor alcohol solubility.

Origin Lemongrass is distributed in Africa, Indian subcontinent, South America, Australia, Europe and North America.

Climate

C. flexuosus and *C. citratus* flourish in sunny, warm, humid conditions of the tropics. In Kerala, lemongrass grows well between 900 and 1250 m from mean sea level. Both species produce highest oil yield per tonne of herbage where the rainfall averages 2500-3000mm annually.

Soil

In sandy loam and red soils, it requires good manuring. Soils of pH 5.5 to 7.5 are utilized. *C. citratus* is more commonly grown on soils with higher acidity than *C. flexuosus*.

Nursery

Lemongrass seeds have a dormancy of a few weeks and they lose viability in a few months. The seeds collected during the months of January-February are usually sown in the nursery during April-May. Germination is very poor if sown after October.

Transplanting

The seedlings raised in the nursery beds are transplanted in the field at 6-7 leaf stage. 50-70 days old seedlings are planted during the monsoon season.

Manures and Fertilizer

Lemongrass requires 275 kg N, 50 kg P2O5 and 175 kg K2O/ha/annum. Under rainfed conditions of Kerala, application of 100 kg N in 3 to 4 split doses was found to be optimum though a response up to 200 kg was recorded. The application of 50 kg/ha each of P2O5 and K2O as a basal dose gave encouraging results.

Irrigation

In case of drought, the crop should be irrigated every alternate day for about a month after planting. It is recommended that 4 to 5 irrigations are required during the period from February to June under North Indian conditions.

Weed Control

The first 25-35 days after planting is the crop-weed competition period. Generally, 2-3 weedings are necessary in a year. Among herbicides, diuron at 1.5 kg ai/ha and oxyfluorfen at 1.5 kg ai/ha are effective for weed control.

Intercropping

In new plantations of cashew, mango and coconut, lemongrass is cultivated during the initial 4 to 5 years of plantation establishment.

Pests and Control

Spindle bug (*Clovia bipunctata*) has been observed at Odakkali and severe damage by a stem boring caterpillar of *Chilotrea* sp. under North Indian conditions have been reported. Spraying malathion (0.3%) can control the insects.

Harvesting

Harvesting is done by cutting the grass 10 cm above the ground level, with the help of sickles. The number of harvests in a year depends on the climate, temperature, rainfall and humidity and soil fertility. Generally, the crop harvest in humid condition.

Nutrition Garden: A Sustainable Way Towards Food and Nutritional Security

Article ID: 35025

J Lenka[1], P Sahu[2], S. S Das[3], A Das[4]
[1]Scientist, ICAR-Indian Institute of Soil Water Conservation, Regional Centre, Koraput.
[2]Scientist, ICAR-Indian Institute of Water Management, Bhubaneswar.
[3]Scientist, ICAR-Central Institute for Sub tropical Horticulture, Lucknow.
[4]Scientist, ICAR-Central Institute for Sub tropical Horticulture, Regional Centre, Malda.

Introduction

Fruit and vegetables play an important role in balanced diet by providing vital vitamins and minerals. In order to maintain our daily requisite quantity and kind of fresh fruit and vegetables for a family, it is advisable to have nutrition garden to grow them in backward or near-by house or near the school. Nutrition garden by self can offer fresh organically chemical free fruits and vegetables. A diet rich in fruits and vegetables has been shown to prevent neurological disorder, cancer and different types of diseases.

Kitchen garden or home garden or nutrition garden is primarily intended for continuous supply of fresh vegetables for family use. Various types of vegetables are grown in available land for getting a variety of nutritious rich vegetables. Family members participate for different works related to sowing, intercultural operation, irrigation and harvesting on daily basis. Area of nutrition garden, selected crops etc. and layout depend on availability of land. Land will not be a limiting factor for rural area, and scientifically laid out garden can be established but in urban areas, land is a limiting factor and very often crops are raised in limited available area or in terraces of buildings. Pot cultivation or in cement bags or in walls some high value salad and leafy vegetables are also feasible in cities.

Advantages of Nutrition Garden

1. Supply fresh fruits and vegetables high in nutritive value.
2. Supply fruits and vegetables free from toxic chemicals.
3. Help to save income on purchase of vegetables.
4. Induces children on awareness of dignity of labour.
5. Vegetables harvested from kitchen garden taste better than those purchased from market.

Selection of Site

Choice for selection of site for a nutrition garden is limited due to shortage of land in homestead. Usually, a kitchen garden is established in backyard of house, near water source in an open area receiving plenty of sunlight. Size and shape of kitchen garden depends on availability of land, number of persons in family and spare their time available for its care. Nearly five cents of land (200 m^2) are sufficient to provide vegetables throughout year consisting of five members for a family. A rectangular garden is more preferred than to a square plot or a long strip of land.

Fig.1 Different forms of Kitchen garden

Layout of Kitchen Garden

Layout of garden and selection of crops varies each season depends on agro-climatic conditions prevailing in the area. Depending on climatic and seasonal changes, modifications are to be done in layout and crop allotment.

General Criteria for Kitchen Gardens

1. Perennial vegetables like drumstick and curry leaf should be allotted to one side of the garden so that they may neither shade remaining plants nor they interfere with other intercultural operations. Shade loving vegetables like water leaf may be planted in perennial plot. One or two compost pits may be provided on one corner of the garden for effective utilization of kitchen and farm waste.
2. Fences on all sides should be made with barbed wire or with live stakes. Fencing on four sides may be planting ivy gourd, dolichos bean, trailing cowpea, chekkurmanis and ridge gourd. Planting agathi (*Sesbania grandiflora*) at 1.0 m. distance along the fence for strongly support the fence. An arch made of red or green basella may be planted at entry point or gate of kitchen garden.
3. After selecting the areas for perennial crops, remaining portion is divided into 6-10 equal plots for raising annual vegetable crops. By following scientifically package and practices such as crop rotation, three annual crops can be raised in the same plot. Companion cropping cropping, inter cropping and mixed cropping can be followed for effective utilization of space.
4. Provide walking path at centre as well as along four sides. Path can be made attractive by planting red and green amaranth, indeterminate tomato on either side or different colored marigold.
5. Utilize ridges, which separate individual plots for growing tuber and root crops
6. As continuous cropping is done in a nutrition garden, fertility and texture of soil may be maintained by applying adequate quantities of organic manure frequently. Organic farming should be given thrust for a home garden. However, in order to harvest good crop, chemical fertilizers are also essential.
7. Since fresh vegetables are directly utilized for home consumption, clean cultivation, mechanical removal of pest / disease affected plants, planting of resistant varieties, biological control, and use of bio-pesticides or bio-fungicides for pest and disease control in a kitchen garden is a must.
8. In a kitchen garden, preference should be given to long duration and steady yielding varieties than high yielding ones, which require constant care.
9. Crop arrangement: While arranging crops in each sub-plot, care should be taken to plant varieties / crops at ideal time of planting or season. Principles of crop rotation also should be followed in continuous cropping.
10. Cropping patterns for a model kitchen garden were given below. However, choice of the crop depends on the likes and dislikes of family members.

Cropping Pattern of Kitchen Garden During Different Season

Plots	May-June to September-October	September – October to December-January	December-January to May-June
Annual crops			
	Bitter gourd	Yard long bean	Snake gourd
	Brinjal and chilli		Okra
	Ash gourd	Pumpkin	Amaranth
	Bushy / semi-trailing cowpea	Tomato	Cucumber / OP melon
	Okra	Ash gourd	Chilli / brinjal
	Pumpkin	Okra	Yard long bean
Perennial crops			
Fruits	Pineapple		
Vegetables	Taro, elephant foot yam, yams, Chinese potato, tapioca		
Spices	Perennial chilli, ginger, turmeric, mango ginger		
Border of walking paths	Amaranth, bush cowpea, bush dolichos bean		
Fence			

Perennials	Chekkurmanis, Ivy gourd, agathi, giant granadilla
Rainy season	Sword bean, clove bean
Winter season	Ridge gourd, yard long bean
Rainy to summer (July-February)	Dolichos bean, winged bean

Integrated Crop Management

1. Use of quality seed and treat the seed with proper bio-formulations
2. Use well decomposed compost, FYM, Vermicompost, neem cake, pongamia cake to meet the nutrient requirement of crops.
3. Go for organic residue mulching with the help of dry crop residue available in the farm site.
4. Crop rotation with leguminous crops to maintain soil fertility and health.
5. Keep the crop free from weed by manually or by finger weeder in the early growth stage.
6. Use bio-pesticides or neem-based insect disease and pest control in kitchen garden.

Harvesting, Consumption and Marketing

1. Harvesting of the produce as per daily requirement of the family.
2. The surplus amount can be harvested at appropriate stage and sold in the local area to fetch some additional benefits to the farmers.
3. Some vegetables can be utilized for value addition like jam, jelly, sauce pickle and chips.

State Initiatives to Promote Kitchen Gardens

1. Odisha Livelihood Mission, under Panchayati Raj and Drinking Water department, as part of the farm livelihood/promotion of Nutrition sensitive Agriculture is promoting kitchen gardens. The expansion plan of kitchen garden includes capacity-building of the *Krishimitras on* nutrition garden/backyard kitchen garden.
2. The Karnataka Horticulture department with funds from MGNREGA is developing kitchen gardens called 'Akshara Kaitoota' in government schools to promote consumption of vegetables and fruits. This is in addition to the vegetable gardens already existing in many schools.
3. In Chhattisgarh, there is convergence of MGNREGA with the Panchayat and Rural development departments, to secure livelihood for rural households by promoting kitchen gardens.
4. Jharkhand Poshan Vari initiative provides for backyard kitchen gardens where women grow cereals, pulses and vegetables to tackle poor nutrition and also for earning income[5].
5. Tamil Nadu Horticulture Department has tied up with the School Education Department to establish roof gardens in Odisha Livelihood Mission, under the schools to create awareness on importance of vegetables and fruits. The produce from the gardens is used in school kitchens serving nutritious noon meal scheme.
6. A joint initiative by Department of Women and Child Development, Maharashtra under its Rajmata Jijau Nutrition Mission and Reliance Foundation has developed kitchen gardens at anganwadi centres to grow variety of fruits and vegetables to improve diet.

Conclusion

Nutri-gardens can assist strengthen food security and improve income generation and livelihoods and the promotion of nutrition gardens as a sustainable practice to improve the nutrition as well as food security by contributing significantly to dietary diversity. The Government of India launched several missions with the objective of a multi ministerial convergence mission to ensure attainment of a malnutrition-free India by 2022. It calls for creating synergy and linking the schemes of other key departments through convergence mechanism to achieve a common goal. Rural youth and households are encouraged to develop vegetable gardens and increased their consumption pattern. It combats malnutrition by promoting healthy eating and improving agro-ecological practices The Ministry of Human Resource Development has developed guidelines for school nutrition (kitchen) gardens in government and aided schools under the midday meal scheme. There are proven initiatives across states, which can learn from each other's experience and replicate best practices.

Properties and Potential Use of Spent Mushroom Substrate

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Mohan Babu Y N[1], Pepakayala Varalakshmi[2]

[1]Teaching Associate, Department of Agronomy, Kadiri Baburao College of Agriculture, Affiliated to Acharaya N G Ranga Agricultural University, C.S. Puram, Andhra Pradesh-523112

[2]Ph.D Scholar, Department of Soil Science and Agricultural Chemistry, College of Agriculture PJTSAU, R-Nagar, Hyderabad- 500030.

Agricultural sustainability depends mainly on the development of strategies that decreases the use of external inputs such as agrochemicals and avoiding its deleterious impact on the environment and soil. Mushroom farming today is being practiced in more than 100 countries and its production is increasing at an annual rate of 6-7%.

The commercially grown species in India are button and oyster mushrooms, followed by other tropical mushrooms like paddy straw mushroom, milky mushroom, etc. The compost released after the harvest of one full crop of mushroom, beyond which extension of crop becomes unremunerative is called as the 'spent mushroom substrate' (SMS). The spent substrate from different mushrooms varies in its physical, chemical and biological properties and each one has its own specific utility.

Spent Mushroom Properties

SMS mainly composed agricultural residues such as sawdust, sugarcane bagasse, oil palm empty fruit bunch, wheat straw-bedded horse manure, hay, poultry manure, ground corncobs, cottonseed meal, cocoa shells, gypsum and other substances. (Jordan et al. 2008).

The traits and composition of SMS vary in different mushrooms due to difference in types of residues and waste used for mushroom cultivation and their subsequent utilization by mushrooms. The nutrient composition of spent mushroom substrate (SMS) normally contains 1.9:0.4:2.4%, and 1.9:0.6:1.0% N-P-K before and after weathering respectively. (Gupta et al.,2004). Due to presence of certain chloride and sulphate salts the conductivity of SMS obtained from different sources usually varies from 1.9 to 8.3 mmhos/cm depending upon the concentration of salts present in substrate.

Devonald (1987) reported that the pH of fresh SMS is generally in the range of 7.00-8.04 which subsequently increases during weathering. The density of fresh SMS is in the range 0.15 to 0.24 g/cm^3 and its volume decreases over the time lapse SMS contains much fewer heavy metals than sewerage sludge, which precludes its classification as hazardous substance (Wuest and Fahy, 1991).

Due to presence of huge number of salts and other harmful elements spent mushroom substrate need to be weathered to remove harmful salts, to make it suitable for use as a manure in agriculture. Otherwise, substrate may cause deleterious effect on plant growth and soil.

During weathering process SMS was exposed to different weather parameters like temperature, rainfall sunlight and microbial degradation, for minimum 8 months. The weathering process is enhanced by facilitating adequate aeration by reducing the time for biological activity within the SMS (Iteinemann et al., 2002).

Applications of Spent Mushroom Substrate in Agriculture

The spent substrate has been found to be nutritionally rich with respect to primary nutrients and being having high cation exchange capacity, which can be utilized for the purpose of raising horticultural and cereal crops. Using spent mushroom substrate as feeding material for vermicomposting, plants diseases management, preparation of organic-mineral fertilizer and bioremediation of the contaminated soils are the other options of using SMS. The SMS can be utilized for undermentioned means and the applications below were scientific experiments.

Organic Manure

Spent mushroom substrate is nutrient-rich, contains significant amount of primary nutrients and major fraction of total nitrogen is present in bounded with lignin, humic and other high molecular weight substances can be used as bottom fertilizer. Due to slow mineralization rate of spent mushroom substrate it retains its quality as an organic matter and will increase the activity of soil micro-organisms and earth worms, help develop a good crumb structure, improve the physical structure of the soil. The research trail is conducted for studying the impact of SMS on several crops have shown that there is significant increase dry matter content of plants with incorporation of increasing amount of weathered or unweathered SMS in soil (Chong et al., 1987).

Bio Remediation

Bioremediation is the use of living organisms such as bacteria, fungi, or green plants, to remove or neutralize unwanted contaminants in air, soil, or water. The use of SMS as a bioremediating agent is supported by its properties of a nearly neutral pH and notable content of organic carbon and calcium. SMS also has the ability to chemically adsorb the organic and inorganic pollutants, while the diverse category of microbes it harbours have the capability of biological breakdown of the organic xenobiotic compounds present in soil and water. The most important components of SMS for the treatment of industrial waters are limestone, gypsum, organic matter and its volume. The microbes, especially actinomycetes (*Streptomyces* sp. and *Thermomonospora* sp.) present in spent mushroom substrate also have strong pollutants catabolizing capabilities which result in decreased level of pollutants in contaminated soil after incubation with SMS.

Biocontrol for the Disease

The biological analysis of SMS extract shows that it contains a *Pseudomonas* and a *Bacillus*. SMS obtained from different growers' harbours different mycoflora and shows differences in its effect on inhibition of conidial germination and disease suppression. The inhibitory properties of SMS remain unaffected even after autoclaving and filter sterilization (Yohalem et al., 1994) of aqueous extract. The organic amendment of soil with SMS helps in restricting the root knot infestation of tomato plant by *Meloidogyne incognita*. The extract from SMS also inhibits the conidial germination of *Venturia inaequalis,* causal agent of apple scab; *Cochliobolus carborum*, causing disease on maize and *Sphaeropsis sapinea*, causing disease on red pine. The weekly/biweekly application of spreader/sticker amended SMS extract, starting from green tip to petal fall of apple tree reduces the scab- affected leaf area on apple plants.

Conclusion

SMS has the potential of solving several agriculture related problems. However, it requires some early treatments like desalting/prolonged leaching and recomposting for added advantages. The exploitation of spent mushroom substrate for the management of environment, agriculture and production of recyclable energy requires strict watch on its physical, chemical and microbiological properties. Its utilization will not be restricted to a single application but will only be limited by the resourcefulness and ingenuity of mushroom farmers, scientists, and entrepreneurs.

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Soil Carbon Sequestration to Mitigate Carbon Dioxide Emissions

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Mohan Babu Y N[1], Pepakayala Varalakshmi[2]

[1]Teaching Associate, Department of Agronomy, Kadiri Baburao College of Agriculture and Horticulture, Andhra Pradesh.

[2]Ph.D. Scholar, Department of SS&AC, College of Agriculture, PJTSAU, Hyderabad.

Introduction

In many ways, carbon is life. A chemical element, like hydrogen or nitrogen, carbon is a basic building block of biomolecules. It exists on Earth in solid, dissolved and gaseous forms. For example, carbon is in graphite and diamond, but can also combine with oxygen molecules to form gaseous carbon dioxide (CO_2). The build-up of carbon dioxide and other 'greenhouse gases' in the atmosphere can trap heat and contribute to climate change. Carbon dioxide is the most commonly produced greenhouse gas and it produced both in nature and by human activities. Man-made carbon dioxide can come from burning coal, natural gas and oil to produce energy. Biologic carbon dioxide can come from decomposing organic matter, forest fires and other land use changes. Carbon sequestration is the process of capturing and storing atmospheric carbon dioxide. It is one method of reducing the amount of carbon dioxide in the atmosphere with the goal of reducing global climate change.

Sources of Carbon Dioxide Emissions

There are both natural and human sources of carbon dioxide emissions. Natural sources include decomposition, ocean release and respiration. Human sources come from activities like cement production, deforestation as well as the burning of fossil fuels like coal, oil and natural gas.

Role of Agriculture in Global Warming

Agriculture occupies a larger portion of global land area (about 35%) than any other human activity. Because of its scale and intensity, agriculture emits a large quantity of greenhouse gases into the atmosphere. It presently accounts for about 25% of the CO_2, 50% of the CH_4 and 70% of the N_2O released globally via human sources. However, because farmlands are intensively managed, farmers can, to some extent, control the amounts of these gases released. For example, by choosing different practices, it may be possible to reduce emissions. Farmlands may, in fact, even be made to absorb more gases than they emit, thus helping to absorb CO_2 emitted from fossil fuels and restore air quality. This is of importance with regards to C, because when this occurs the land acts as a "sink" or storehouse for C.

One of the main options for greenhouse gas (GHG) mitigation identified by the IPCC is the sequestration of carbon in soils. Since the breaking of agricultural land in most regions, the carbon stocks have been depleted to such an extent, that they now represent a potential sink for CO_2 removal from the atmosphere. Improved management will however, be required to increase the inputs of organic matter in the top soil and/or decrease decomposition rates. There are two main types of carbon sequestration: biological and geological.

Scientists are exploring new ways to remove and store carbon from the atmosphere using innovative technologies. Researchers are also starting to look beyond removal of carbon dioxide and are now looking at more ways it can be used as a resource.

Ways to Carbon Sequestration

Geological sequestration: Geological carbon sequestration involves the separation and capture of carbon dioxide (CO_2) at the point of emissions followed by storage in deep underground geologic formations. This is also referred to as carbon (or CO_2) capture and storage (CCS). It involves trapping CO_2 within a cavity in the rock underground. These cavities are either large man-made cavities, such as caverns and mines or the pore space present within rock formations and also binding it chemically to another substance in the ground.

Ocean sequestration: The ocean is the largest sink of atmospheric CO_2 (about 7 petagrams (Pg) per year) (1 Pg = 1 gigaton = 1015 g). Dissolved CO_2 (passively entering the ocean via diffusion from the atmosphere) has already acidified the surface ocean, the most productive region of the ocean. Ocean carbon sequestration (OCS) is a method to distribute CO_2 more evenly throughout ocean depth and minimize surface ocean impacts. There are two major methods of OCS – direct injection and ocean fertilization (promoting photosynthetic fixation of CO_2 by ocean organisms).

Terrestrial sequestration: Terrestrial carbon sequestration is the process through which CO_2 from the atmosphere is absorbed by trees and plants through photosynthesis and stored as carbon in soils and biomass (tree trunks, branches, foliage, and roots.

Management techniques for Carbon sequestration: Various management techniques can be used to increase carbon sequestration in soils. Large uncertainties are associated with quantifying the impact of the various crop management practices on greenhouse gas emissions. Further, the spatial and temporal scales involved in quantifying greenhouse gas emissions from, and C sequestration in, agro-ecosystems make it very difficult to obtain accurate estimates of the GHG emission or C sink values. The uncertainty about future climatic conditions is also a complicating factor because the magnitude of the effect engendered by many of the crop management practices that may be adopted to reduce greenhouse gas emissions are so dependent on climate and weather as they influence primary productivity and thus C inputs into the soil.

Main Agronomic and Related Practices to Increase SOC Sequestration

1. Adoption of no-tillage (NT) or minimum tillage.
2. Adoption of environmental and soil health friendly farming systems.
3. Incorporation of cover crops.
4. Use of mulch either in the form of crop residues or synthetic materials.
5. Minimization of soil and water losses by surface runoff and erosion.
6. Adoption of integrated nutrient management practices for the increase of soil fertility.
7. Use of organic amendments.
8. Promotion of farm forestry.

Impacts of Carbon Sequestration

1. About 25% of our carbon emissions have historically been captured by Earth's forests, farms and grasslands. Scientists and land managers are working to keep landscapes vegetated and soil hydrated for plants to grow and sequester carbon.

2. As much as 30% of the carbon dioxide we emit from burning fossils fuels is absorbed by the upper layer of the ocean. But this raises the water's acidity, and ocean acidification makes it harder for marine animals to build their shells. Scientists and the fishing industry are taking proactive steps to monitor the changes from carbon sequestration and adapt fishing practices.

Farm Resource Management – A Key to Conservation Agriculture

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Kalaiselvi P.[1], M. Gomathy[2]
[1]Assistant Professor (ENS), Department of Natural Resource Management, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Periyakulam.
[2]Assistant Professor (Agrl. Microbiology), Agricultural College and Research Institute, Killikulam.

Introduction

The main role of conservation agriculture is to conserve natural resources for improving livelihood opportunities and enhancing the quality of the millions of small and marginal farmers living in abject poverty. The conservation agriculture has been identified as one of the technological options to meet the global challenges of increasing food production and conserving environment, thereby to improve food and nutritional security and alleviate poverty. Conservation agriculture is a range of soil management practices that minimize effects on composition, structure and natural biodiversity and reduce erosion and degradation. The conservation agriculture practice also includes crop residue management. Crop residue, a precious organic farm resource; which could be effectively managed to achieve sustainability and higher productivity.

Importance of Crop Residues

For improving soil health, green manure is advocated but the farmers especially small farmers are not in a position to adopt this practice. Proper crop residue management can form an important component of soil fertility management. It is currently being burnt, especially rice residue in the high-yielding states like Punjab and Haryana, leading to degradation of natural resources. Efficient crop residue management can play a vital role in refurbishing soil productivity as well as in increasing the efficiency of inorganic fertilizer. Residue management is receiving a great deal of attention because of its diverse and positive effects on soil physical, chemical and biological properties. Crop residues must be considered a natural resource and not a waste.

Availability of Crop Residues

Total crop residue production in India varied from 185 to 356 million tons of which about one-third is available for recycling by soil incorporation or surface retention. Of the total crop residue production in India, wheat and rice together contributed about 60 per cent. The estimated crop residue produced in the rice-wheat system, covering an area of about 10 million hectares, is about 126 million tonnes, of which 42 million tonnes is available for recycling. By taking the prevailing price, the fertilizer replacement value has been estimated to be about Rs. 3.6 billion/year.

Residue Management Options

There are several options available to farmers for the management of crop residues, including burning, baling and removal, incorporation and surface retention. Burning, in addition to promoting loss of organic matter, nutrients and soil biota, also causes air pollution and associated ill effects on human and animal health. Baling is not practiced at the farmer level. Incorporation is a better option but it requires large amounts of energy, cost and time, also leads to temporary immobilization of nutrients, especially nitrogen. So, the crop residues can be effectively managed by surface retention.

Importance of Surface Residue Retention

Moderates soil temperature: Surface residue retention moderates soil temperature by avoiding direct exposure of soil to sunlight and/or acting as physical barrier to the heat loss from the soil as well as by increasing the dielectric constant due to moisture conservation. During summer, the maximum soil temperature remains lower and during winter the minimum temperature remains higher compared to bare soil which helps in avoiding adverse effect on crop.

Conserves soil moisture: The surface retained crop residues act as mulch which considerably reduces the evaporation losses from soil and helps in conserving soil moisture. It is of immense importance in areas having scarce water resources. In irrigated areas, it will help in reducing the irrigation water requirement of the crop leading to less ground water mining.

Helps building up organic carbon: The slow decomposition compared to incorporation helps in building up the soil organic carbon. The soil organic carbon build up was higher in surface retained residues. In case of burning, there was marginal decrease in soil organic carbon.

Reduces soil erosion: The surface retained residues absorbs the rain drop impact, helps in maintaining the soil structure which leads to increased infiltration and reduced runoff. Moreover, it acts as a physical barrier for water runoff as well as direct effect of wind on soil.

Reduces nitrogen immobilization: The surface retained crop residues due to limited contact with soil avoids short-term tying up of nutrients as is observed in incorporation. The top dressing of nitrogen in surface retained residues must be done before irrigation to avoid interception by the residue and the volatilization losses.

Reduces weed infestation: Crop residues may influence the weed seed reserve in the soil directly or indirectly and also the efficiency of soil-applied herbicides. Residue retention on the soil surface in combination with a zero-till system may also significantly contribute to the suppression of weeds. Zero-till systems help reduce weed emergence through avoiding exposure to light and through mechanical impedance to the weed seed. Due to its influence soil temperature and soil moisture, which may increase or decrease weed germination depending on the types of weeds, soil conditions and type and quantity of crop residue. At lower residue levels the weed population may be higher than in residue-free conditions, but at higher residue levels weeds will be reduced considerably.

Conclusion

Crop residue retention on the soil surface has multifarious benefits. It conserves soil moisture, moderates' temperature, suppresses weeds, improves soil physicochemical properties and helps to make the system sustainable. However, further intensive investigations are required on the residue load that can be sustained for a long time, as well as the potential effects on pests, diseases and weeds.

Organic Agriculture - A Sustainable Approach in the Present Era

Article ID: 35029

P. Seetharamu[1], D. Sekhar[1], G. Ramarao[1]
[1]ANGRAU, Regional Agricultural Research Station, Chintapalle, Visakhapatnam-531 111, A.P.

The present farming practices are becoming unsustainable as substantiated by diminishing crop productivity, harmful effects on environment, human health and increasing pesticide residues in crop produce, etc. This requires an alternative approach and environmentally safe agriculture method to increase the productivity of crops.

Organic farming is a system that rule out use of chemical compounds *Viz*., inorganic fertilizers, insecticides, fungicides, herbicides, growth regulators, etc. It can maintain the soil health, agro ecosystems including biodiversity, microbial activity and human health (Shukla et al., 2011). The major approaches included in organic farming are improved agro ecological engineering methods, market intelligence, organic standards and certification/regulatory mechanism. India produces a wide range of food crops including cereals, pulses, oilseeds, fruits and vegetables. Public is giving more emphasis on organic products over than the inorganic food products. Initially 3-4 years, organic farming practices are not cost- effective but later on economic benefits will be increased every year since it reduces the cost of cultivation and enhances soil fertility levels and the same way it is preventing soil erosion. Similarly, medium- and long-term agricultural interferences have optimistic impact on the restoration and maintenance of the natural ecological balance. Organic food production and consumer demand is increasing recent times in developed and developing countries. The increasing demand in organic food is due to awareness among the consumer and producer about the negative consequences associated with synthetic chemical pesticides. Due to residual problem and toxicity to the living environment the synthetic chemical pesticides are not permitted in organic food production. In this scenario, cultural practices such as, minimum tillage, crop rotations, mix/inter- cropping, cover crops, bio fertilizers and bio pesticides from natural materials like plants, microbial and animal origins are given enormous importance to develop better alternatives to chemical pesticides by considering their eco-friendliness, multiple modes of action and specificity against target pests. Use of these biocides are safe to environment, facilitates the survival, conservation and augmentation of natural enemies of pests *Viz*., predators, parasitoids, entamo pathogenic micro-organisms. The practices followed in organic farming which is eco-friendly and cost-effective measures to encounter various pests and diseases in organic farming are described hereunder.

Organic Manures

Organic manures like Farm Yard Manure, vermicompost, neem cake, sheep and poultry manures play a major role in organic farming to supply major and micro nutrients and also improve soil physical properties, chemical properties and biological activity.

Green Manure Crops

Green manures are crops grown and in situ incorporation in field for the purposes of improving soil organic matter and soil structure by supplying nitrogen and other nutrients for a following crop. It also prevents leaching of soluble nutrients from the soil. The most important green manure crops are belonging Leguminaceae *viz*., sunhemp, dhaincha, pillipesara, cluster beans and *Sesbania rostrata*, cowpea, etc.

Crop Rotation

Crop rotation is a process of growing different crops in succession on a piece of land in a specific period of time with an object to get maximum profit from least investment without impairing soil fertility. The concept of crop rotation increases the security and stability of income and the total production of the farm if the different inputs as well as outputs are added together. The impact of crop rotation depends greatly on the length of the rotation cycle along with market, climate and soil fertility. Our today's utmost need is to get sustainable production without detrimental effect on environment, ecosystem and human health. These parameters may be fulfilled to an extent by adopting proper crop rotation under organic farming since crop rotation plays a key role in to prevent the build-up of soil borne pests and diseases, weeds and to allow for the replenishment and efficient use of soil fertility.

Eg: Cereals followed by rice fallow pulses
Cole crops followed by legumes
Solanaceae vegetables followed by cereals
} minimizes the various pests and diseases

Inter Cropping

It is growing two or more crops simultaneously on the same piece of land with a definite row pattern which encourages buildup of natural enemies. Eg: Bengal gram+ Coriander, Groundnut+ Bajra, Cotton+ Cowpea.

Cover Crops

Cover crops encourage soil microbial activity which in turn involve in decomposition of organic matter and help in improvement of soil properties. These cover crops also prevent the soil erosion, soil fertility enrichment. Eg: *Pueraria phaseoloides*, *Calapagonium mucanoids* and *Mimosa invisa* are popular Leguminaceae cover crops to accumulate nitrogen in soil.

Trap Crops

Growing of preferred or most attracted plants for the major pests and their natural enemies in the vicinity of a major crop to act as a trap and later it can be destroyed by mechanical methods or by using plant derived insecticides.

Eg: Bhendi is a trap crop in cotton to attract spotted bollworm.
Marigold as trap crop to Gram caterpillar.
Castor or sunflower in groundnut to tobacco caterpillar.
Napier grass /Desmodium in maize to fall armyworm.

Pheromone Traps

Pheromone traps are an effective monitoring tool in scouting of insect pests in various crops. The sex pheromones are specific in their biological activity, the males responding only to a specific pheromone of the female of the same species, and their reactions are directed towards the air currents carrying the odour. The recommended pheromone traps 4-5/acre.

Helilure - *Helicoverpa armigera;* Gossyplure- Pink bollworm; Littolure for *Spodoptera litura;* Lucilure for *Leucinodes orbonalis;* Ferrolure for *Rhynophorus ferrugeinus;* Rhinolure- Rhinoceros beetle.

Biofertilizers

Biofertilizers are preparations containing living microorganisms such as nitrogen fixers or phosphate solubilizers, which are useful for agricultural production. Biofertilzers enhances the nutrient availabity in soil and also improves the soil texture and structure. Rhizobacteria, Azolla, *Azotobactor* and *Azospirillum,* VAM increase nitrogen availability; *Bacillus*, *Pseudomonas*, *Aspergillus*, *Mycorrhizae* increase phosphorus availability whereas *Acidothiobacillus ferrooxidans, Paenibacillus spp., Bacillus mucilaginosus,* etc increase potassium availability in soil.

Botanicals

Botanical pesticides are potential alternative sources and are not harmful and ecologically safe. It is also known as green insecticides. India possesses the largest diversity of plant species having 47,000 plant species and Accounts for 7-8% of the recorded species in the world. New active principal compounds are being isolated and characterized every day from plants and other biological sources. In general, anti-insect compounds are accumulated in several species of *Myrtaceae, Lauraceae, Rutaceae, Lamiaceae, Asteraceae, Apiaceae, Cupressaceae, Poaceae, Zingiberaceae* and *Piperaceae* families.

Parasites and Predators

In organic agriculture the entomophages plays a pivotal role. Natural enemies *viz.,* predators and parasitoids that dampen pest insect populations. Due to absence conventional toxic pesticides in organic agriculture, it is likely to encourage the natural enemies of pest insects. But that encouragement may not be enough to provide substantive control of chronic pests without additional changes in the agro-ecosystem, which provide habitat for the pests and their natural enemies. Predators like Coccinellids, mantids, dragonflies, spiders, egg parasitoids: *Trichogramma*, *Telenomus*; Larval parasitoids; *Bracon, Apanteles*; Pupal parasitoids like *Xanthopimpla* etc. In India, the weeds like water hyacinth, parthenium and salvinia have been successfully controlled by introduction of biocontrol agents like *Zygogramma, Neochetus, Ortheris* etc.

Microbial Management

Microbial pesticides derived from fungi, bacteria, viruses, nematodes and protozoa and also some other compounds produced directly from these microbes such as metabolites are main microbial pest management agents in organic agriculture. Up to now, there are more than 3000 kinds of microbes that cause diseases in insects. Over 100 bacteria have been identified as insect pathogens, among which *Bacillus thuringiensis* (Bt) has got the maximum importance as microbial control agent. Entomopathogenic fungi belonging to 100 genera are recorded and only 10 species have been commercially exploited of which *Beauveria bassiana, Metarhizium anisopliae, Nomuraea rileyi, Lecanicillium lacanii, Hirsutella thompsoni* has been exploited to management many pests like root grubs, caterpillars, BPH, coffee berry borers, Helicoverpa, thrips, whiteflies, aphids, caterpillars, weevils, grasshoppers, ants, colorado potato beetles and mealybugs (Amit Arora et al. 2017). More than 1000 insect species viruses have been isolated such as nuclear polyhedrosis virus (NPV) infested 525 insects worldwide. The two major groups of entomopathogenic nematodes identified are *Steinernema* (55 species) and Heterorhabditis (12 species) (Koul, 2011).

Biocides for Plant Disease Management

A potent bio control agent *Trichoderma viride* for the management of soil borne diseases *viz., Fusarium*, *Phytopthara*, *Scelerotia* etc. *Pseudomonas fluorescence* is another important potential bio control agents for the disease-causing microorganisms transmit through seeds and seed materials (Wei et al. 1996). It is used to manage the diseases like blast (paddy and ragi), sheath blight (paddy), root rot and wilts (groundnut, gingelly, sunflower, redgram, greengram, blackgram, cotton and banana), damping off (vegetables), club root (cabbage and cauliflower) and anthracnose (mango and banana). *Bacillus subtilis* is used to suppress several disease-causing pathogens *viz., Fusarium sp.*, *Rhizoctonia solani*, *Sclerotium rolfsii*, *Sporisorium reilianum* and *Verticillium dahliae* (Liu et al. 2013).

Conclusion

Organic agriculture is gaining momentum as an alternative method to the modern system. An environmentally sustainable system of agriculture like organic farming will be able to maintain a stable resource balance, avoid over exploitation of renewable resource, conserving inherent soil nutritional quality and soil health, and biodiversity. It will lead us to sustainable agriculture and create a sustainable lifestyle for generations to come.

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Quantification of Organic Nutrients for Organic Farming

Article ID: 35030

G. Senthil Kumar[1]

[1]Assistant Professor (Agronomy), Department of Rice, Tamil Nadu Agricultural University, Coimbatore – 641 003, Tamil Nadu, India.

Manure

Manure is the organic material derived from animal, human and plant residues, which contain plant nutrient in organic form. They are added to improve the physical condition of the soil, to replenish and keep up its humus status thus improving soil fertility, to maintain the optimum conditions for the activities of soil microorganisms.

Organic Manures

Organic manure is normally called as manure. This may be bulky (or) concentrated organic manure depending upon the volume and nutrient content of the manure.

Bulky Organic Manures

These are bulk in quantity and low in plant nutrient.
1. Farm yard manure.
2. Compost.
3. Night soil.
4. Sewage and sludge.
5. Green manure.

Farm Yard Manure

Most commonly used organic manure. It consists of a mixture of cattle dung, the bedding used in the stable and straw and plant stalks fed to cattle. Sheep manure and poultry manure also called farm yard manure.

Compost

Composting is the process of reducing vegetable and animal refuse (rural or urban) to quickly utilizable condition for improving and maintaining soil fertility. When compost is made from farm waste and rural waste, it is called rural compost. When town-refuse is composted, it is called town compost.

Trap Crops

Growing of preferred or most attracted plants for the major pests and their natural enemies in the vicinity of a major crop to act as a trap and later it can be destroyed by mechanical methods or by using plant derived insecticides.

Sewage and Sludge

The sewage and sludge which contain large quantities of plant nutrients are used for growing sugarcane, vegetables and fodder crops near large towns by organizing sewage farms.

Nutrient Content of Bulky Organic Manures

Manure	Percentage composition		
	N	**P_2O_5**	**K_2O**
Cattle dung	0.40	0.20	0.20
Cattle urine	1.00	traces	1.35
Sheep and goat dung	0.75	0.50	0.45
Sheep and goat urine	1.35	0.05	2.10
Sheep and goat manure	3.00	1.00	2.00

Poultry manure	3.03	2.63	1.40
Horse manure	2.00	1.50	1.50
Horse urine	1.35	traces	1.25
Pig dung	0.60	0.50	0.40
Pig urine	1.10	0.10	0.45
Farm litter compost	0.50	0.15	0.50
Rural compost	1.22	1.08	1.47
Town compost	1.40	1.00	1.40
Vermi-compost	3.00	1.00	1.50
Night soil	5.50	4.00	2.00
Paddy straw	1.50	1.34	3.37
Sugarcane trash	2.73	1.81	1.31
Sewage sludge	1.5-3.5	0.75-4.00	0.3-0.6

Green Manures

Green manuring, wherever feasible is the supplementary means of adding organic matter to the soil. It consists of raising a quick growing crop mostly leguminous plant, and incorporating into the soil. The crops commonly used are sunnhemp *(Crotalaria juncea)* Daincha *(Sesbania aculeata)* and Kolinji *(Tephrosia purpurea).*

Green Leaf Manure

Collection of green leaves from trees like neem, pungam, glyricidia etc. and incorporating them in the field is called green leaf manuring.

Nutrient Content of Green Manure Crops and Green Leaf Manures

Plant	Scientific name	Nutrient content (%) on air dry basis		
		N	**P_2O_5**	**K_2O**
Green manures				
Sunnhemp	Crotolaria juncea	2.30	0.50	1.30
Manila agathi	Sesbania rostrata	3.30	0.60	1.20
Daincha	Sesbania aculeata	3.20	0.60	1.20
Pillipesara	Phaseolus trilobus	2.80	0.50	1.15
Sesbania	Sesbania speciosa	2.71	0.53	2.21
Kolinji	Tephrosia purpurea	3.10	0.52	1.18
Green Leaf manures				
Glyricidia	Glyricidia maculaa	2.76	0.28	4.60
Pungam	Pongamia glabra	3.31	0.44	2.39
Neem	Azadirachta inidca	2.83	0.28	0.35
Gulmohur	Delonix regia	2.76	0.46	0.50
Vadanarayanan	Delonix elata	3.51	0.31	0.43
Subabul	Leucaena leucocephala	3.50	0.48	0.81
Peltophorum	Peltophorum ferrugineum	2.63	0.37	0.50

Concentrated Organic Manures

These are organic manures rich in plant nutrient and low in volume.

1. Oil cakes.
2. Blood meal.
3. Meat meal.
4. Fish meal.
5. Horn and hoof meal.

Nutrient Content of Some Concentrated Organic Manures

Manure	Percentage composition		
	N	P_2O_5	K_2O
Caster cake	4.0-4.4	1.9	1-4
Groundnut cake	6.5-7.5	1.3	1.5
Cotton seed cake (decorticated)	6.9	3.1	1.6
Cotton seed cake (undecorticated)	3.6	2.5	1.6
Linseed cake	5.6	1.4	1.3
Coconut cake	3.4	1.9	1.9
Neem cake	5.2-5.6	1.1	1.5
Safflower cake (decorticated)	7.9	2.2	1.9
Safflower cake(undecorticated)	4.9	1.4	1.2
Sesamum cake	4.7-6.2	2.1	1.3
Mahua cake	2.5	0.8	1.9
Niger cake	4.7	1.8	1.3
Pungam cake	4.0	1.0	1.3
Raw bone meal	3.0-4.0	20-25	-
Steamed bone meal	1.0-2.0	25-30	-
Basic slag	4.0	14-18	1.3
Fish slag	4-10	3-9	1.5
Blood meal	10-12	1-2	1.0
Meat meal	9-11	3.5	-
Horn and hoof meal	10-15	1	-
Press mud	1-1.5	4-5	2-7
Guano (Peruvian bird)	11-16	8-12	2-3

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Tomato (*Solanum lycopersicum*)

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Mrs Kamini Parashar[1], Dr. Aabha Parashar[1], Dr. Prerna Dogra[2], Mr. Omprakash[2], Dr. R. C. Asiwal[2]

[1]Subject Matter Specialist, Krishi Vigyan Kendra, Sirohi (Agriculture University, Jodhpur).
[2]Assistant Professor, College of Agriculture, Lalsot (SKN Agriculture University, Jobner).

Introduction

Tomato (Solanum lycopersicum) is one of the most important vegetable plants in the world. It originated in western South America, and domestication is thought to have occurred in Central America. Because of its importance as food, tomato has been bred to improve productivity, fruit quality, and resistance to biotic and abiotic stresses. The tomato belongs to the extremely large family Solanaceae and is closely related to many commercially important plants such as potato, eggplant, peppers and tobacco.

Tomato occupies a prime position in list of protective foods since it is a rich source of minerals like calcium (48 mg / 100g), sodium (12.9 mg), trace elements, copper (0.19 mg), vitamins like vitamin A (900 IU), vitamin C (27 mg), vitamin B complex (thiamine), essential amino acids and healthy organic acids like citric, formic and acetic acids. The attractive red colour of fruit is due to lycopene and yellow colour is due to carotenes. Peculiar flavour of tomato is due to presence of ethanol, acetaldehyde and a number of volatile flavour components found in fruit. Different forms of tomatine, a steroidal glycoalkaloid, are identified from various parts of plant. Tomato is a good appetizer and its soup is a good remedy for preventing constipation. Because of these facts, tomato serves as anIdeal organism for the family Solanaceae and, specifically, for fleshy-fruited plants.

	
Tomato Seed	**Tomato Seedling**
	
Tomato after transplanting	**Staking on Tomato**
	
Tomato flower	**Tomato fruit**

Varieties

Quiet a large number of varieties differing in their climatic requirements, growth habit, fruit quality, resistance to pest and diseases are developed for specific purposes like fresh market, processing, long distance transport etc. A brief description of important varieties is given below:

Variety	Special features
Arka Rakshak	Triple disease (ToLCV+BW+EB) resistant variety having high yield potential (40-50 tons per acre in 140-150 days). Fruits are medium to large size (75-80g), deep red, very firm with good keeping quality (15-20 days) and long transportability.
Arka Samrat	Triple disease (ToLCV+BW+EB) resistant variety having high yield potential (40-50 tons per acre in 140-150 days). Fruits are large size (100 g), deep red, very firm with good keeping quality (15-20 days) and long transportability.
Avinash	Semi determinate. Fruits firm, round and nipple tipped.
RCT-9	Determinate, Fruits medium large, oblate Tolerant to leaf curl virus tolerant to moisture stress condition.
RCT-11	Semi-determinate, resistant to fruit cracking, good transport quality Fruits round firm with nipple tipped.
Arka Alok	Bacterial wilt resistant, determinate. Fruits square and oblong.
Pusa Early Dwarf	Determinate, Fruits flat oblate.
Sioux	Indeterminate. Fruits small and round
Pusa Uphar	Determinate. Fruits round with thick pericarp, suitable for processing.
Pusa Ruby	Indeterminate. Fruits flat round and suitable for processing.
Pusa Sadhabahar	Suitable for high and low temperature regimes.
Pant Bahar	Resistant to Verticillium wilt and Fusarium wilt. Indeterminate. Fruits flat round and suitable for processing and storage.
Hisar Anmol	Resistant of leaf curl, determinate. Fruits flat round, medium size.

Climate

Tomato is a day neutral warm season crop, which cannot tolerate frost. Cool and dry weather is preferred by the crop and optimum temperature is 21-28^{0}C during day and 15-20^{0}C during night. Night temperature is more critical than day temperature. High temperature results in exerted stigma, dryness of stigma, burning of anther tip, poor pollen dehiscence, low pollen viability and slow pollen tube growth leading to low pollination and fruit set. Incidence of viral diseases also will be more at high temperature. Optimum temperature for colour development of fruit is 21-24^{0}C. Development of colouring pigment, lycopene will be hampered above 27^{0}C Seed germination and pollen germination are adversely affected below 10 Based on night temperature requirement for fruit set, tomato varieties are classified into three.

1. **Normal set varieties:** Set fruits at 15-20^{0}C.
2. **Hot set varieties:** Set fruits above 20^0 C – eg: Philipine, Punjab Tropic, Pusa hybrid1.
3. **Cold set varieties:** Set fruits below 15^0 C – eg: Pusa Sheetal, Avilanche.

Tomato cannot withstand water logging. Hence well drained fairly fertile soil rich in organic matter are preferred. It is moderately tolerant to acid soil having pH 5.5 and ideal pH requirement is 6-7^0 C. Sowing time and seed rate. Under mild climatic conditions, where there is no danger of frost, three crops can be raised in a year. In the hills, seeds are usually sown in March-April. In plains is grown during June to November.

Seed Rate

Open pollinated variety	400-500 g / ha
Indeterminate F2 hybrid	150-200 g / ha.

Seeds are sown in an area of 200-240 m^2 will be sufficient to plant one hectare. Four to five weeks old seedlings are used for transplanting. Hardening of seedling is essential for their establishment in main field and is done by withholding irrigation for one week before transplanting, adding NaCl (400 ppm) to irrigation water or by spray of cycocel (200 ppm) and Zinc Sulphate (0.25%) + 25 ppm proline at time of transplanting.

Main field preparation and transplanting. Seedlings are transplanted on raised beds or on sides of ridges. Field is ploughed 4-5 times and raised beds of 80-90 cm width or ridges and furrows are prepared. Spacing depends on the growth habit (determinate, indeterminate or semi determinate) of variety and various spacing followed are 60 x 30-45cm, 75 x 60cm and 75 x 75 cm. Usually closer spacing results in early and higher yield, but it may affect size of fruits.

Manures and Fertilizers

Manure and fertilizer recommendation for tomato depends on the growth habit and productivity of variety and it varies from state to state. In most of states, in addition to 15-20 tonnes of FYM, N-100-125 kg, P_2O_5-50-60 kg, and K_2O 50-60 kg are recommended for one hectare.

FYM should be incorporated in soil at the time of final ploughing. 1/3 N, Full P and K may be applied as basal dose either just before transplanting or 5-10 days after transplanting. Remaining 2/3 N is applied 20 and 45 days thereafter. Additional dose of 10 kg borax and 5 kg Zinc Sulphate, as basal dose, are also recommended for correcting fruit cracking and to increase yield and fruit quality.

Irrigation

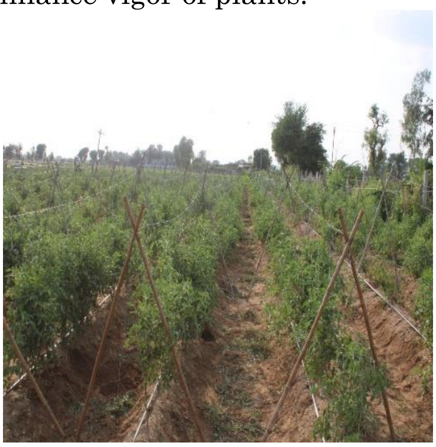
Furrow irrigation is the most common method in tomato and the crop require adequate moisture throughout growth period. Frequency of irrigation depends on the climatic and soil conditions. During summer, crop should be irrigated at 3-4 days interval. Water stress at flowering stage will adversely affect fruiting and productivity. A long spell of drought followed by heavy irrigation leads to cracking of fruits. Similarly, a dry spell after regular irrigation causes blossom end rot. Drip irrigation and sprinkler irrigation are becoming more common in areas of water shortage.

Intercultural Operation

Field should be kept weed free by frequent weeding, hoeing and earthing up. Application of pendimethalin (1.0 kg a.i. / ha) as pre-emergence spray along with one hand weeding at 45 DT is ideal for tomato variety Pusa Ruby. Oxyfluorfen (0.25 kg a.i. / ha) Goal (0.25 kg a.i./ha) and Basalin (1.0 kg a.i. / ha) were also ideal as pre-emergence application. Mulching with straw or plastic is also effective for weed control and for regulating soil temperature.

Staking

All indeterminate varieties are trained with wires, strings or stacks to prevent lodging and loss of fruits by coming in contact with soil. It is done by providing individual stack or by erecting 2-2.5 m long poles on either side of ridges for stretching G1 wire. Branches of plants are supported on poles or strings with twine. Pruning is also generally followed in indeterminate varieties to improve size, shape and quality of fruits. It is removal of unwanted shoots to enhance vigor of plants.



Harvesting

Crop starts yielding by 70 days after planting. Usually, fruits are harvested with hand by a gentle twist so that the stalk is retained on plant. Intervals of harvests depend on season and it is twice in a week during summer and weekly during winter and rainy days. Harvesting maturity depends on the pur pose whether for fresh market, processing, long distance transport etc. Following maturity standards are recognized intomato:

1. Mature green: Fruits fully grown, fruit colour changes from green to yellowish and cavity filled with seeds surrounded by gelly like substance. Harvested for long distance market.

2. Turning or breaker stage: Fruits firm, 1/4t portion of fruit changes to pink in colour, but the shoulder still yellowish green. Harvested for long distance market.

3. Pink stage: 3/4t of whole fruit surface turns pink colour. Harvested for local market.

4. Light red: Entire fruit surface is red or pink but the flesh is firm. Harvested for local market.

5. Red ripe or hand ripe: Fully ripened and coloured. Flesh becomes soft. Harvested for processing and for seed extraction.

Yield

Open pollinated varieties	20-25 t/ha
F1 hybrids	50 t/ha

Grading Storage and Marketing

Fruits after harvesting are graded and packed in bamboo baskets or wooden boxes. Four grades specified by Bureau of Indian Standards are Super A, Super, Fancy and Commercial. Since tomato is a climatic fruit, good care should be taken to remove bruised, cracked and damaged fruits before packing in baskets.

Though tomato can be stored at low temperature, commercially it is not stored in cold storages in the country due to practical reasons. Fruits can be stored for-two weeks and four weeks at 10-13^0 C when harvested at red stage and green stage respectively. Pre-cooling of fruits before storage and transportation enhances storage life.

Processing Tomatoes

Use of tomato for processing is increasing day by day and a variety of products like puree, paste, syrup, juice, ketchup etc. are made. Varieties for processing should have following qualities.

1. Deep red colour which retains even after processing.
2. Low pH – The acidity of fruits affect-heating time required for sterilization of processed product. Longer time is required if pH is high and hence a pH below 4-5 is required for processing.
3. High TSS – Fruits with high TSS yield more finished products / tonne of raw fruits and hence minimum TSS should be 4.5^{0}B.
4. High viscosity and consistency.
5. Firm and easy peeling.
6. Pericarp thickness-should be more than 0.5cm.
7. Crack resistance.
8. Fruits size should be above 50g and oblong in shape.
9. Varieties like Pusa Gaurav, Roma, Punjab Chuhara, Pusa Uphar, Arka Saurabh are especially suited for processing.

Conclusion

General neglect and non-adoption of scientific cultivation practices are the major constraints for poor return from Tomato cultivation in the region. It includes proper planting system, Seedling management, no use of soil and water conservation measures, nutrient application and plant protection measures.

There is no separate package of practices of Tomato cultivation in north region particularly, but only general recommendations have been made in combination with other vegetables crops. There is also a general lack of awareness among the growers about the production technologies and this is perhaps one of the important factors responsible for low productivity of Tomato in the region.

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Ceratocystis fimbriata - A Threatening Pathogen

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Dr. Saranya R.[1]
[1]Scientist, ICAR-Central Arid Zone Research Institute, RRS-Jaisalmer, Rajasthan.

Introduction

Ceratocystis fimbriata belongs to Ascomycota causes wilt-type diseases in many economically important plants. *C. fimbriata* is one of the most aggressive plant pathogens in the genus *Ceratocystis*, causing wilt, canker-stain diseases as well as tissue rot on a wide variety of perennial as well as agronomic crop plants, worldwide (Kile, 1993). It is a large, diverse complex of species with four broad geographic clades, Australasian (AAC), African (AFC), North American (NAC) and Latin American (LAC) Clades. The species as a whole can infect wide variety of hosts, but particular strains are host-specific in nature. Strains (or "types") may be host specific and/or have restricted distributions in some instances. *C. fimbriata* was first reported in sweet potato there it causes black rot on tubers during 1890 (Halsted, 1890).

Morphology

Morphologically, *C. fimbriata* is characterized by perithecia with long necks that taper towards the tips and terminate in 8 to 15 convergent ostiole hyphae.

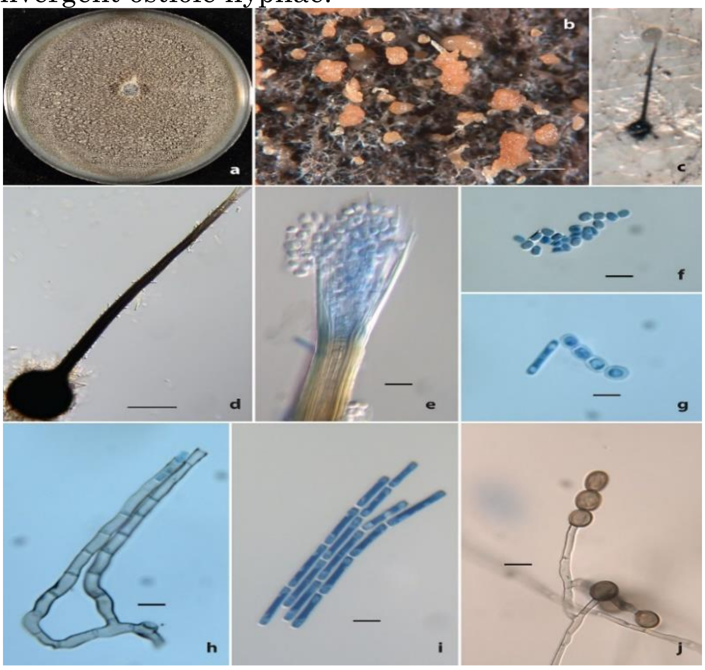

Fig.1
(a)colony morphology
(b) perithecia and ascospore masses.
(c) perithecia with an ascospore mass.
(d) perithecia with a globose base.
(e) divergent ostiolar hyphae with ascospores emerging through the mouth of the neck.
(f) hat-shaped ascospores.
(g) barrel-shaped conidia.
(h) conidiophore with cylindrical conidia released from the phialide.
i) cylindrical conidia.
(j) aleuroconidia.
Scale bar for b = 500 µm, scale bar for d = 100 µm, scale bars for e-j = 10 µm.
Li *et al*., (2015)

Perithecial bases are dark and globose, surrounded by a dense network of hyphae. Asci are evanescent in the early stages of development, while ascospores are characteristically hat-shaped and exuded through the perithecial necks in sticky masses (Hunt, 1956). The fungus also produces chains of cylindrical conidia and aleurioconidia (chlamydospores) that play an important role in the survival of this fungus in the soil (Webster and Butler, 1967). The anamorph of *C. fimbriata* has for many years been accommodated in *Chalara*, but recently, based on a phylogenetic analysis of DNA sequence data, has been recognised as best residing in *Thielaviopsis* (Paulin-Mahady *et al*. 2002).

Host Range

Over 30 types of plants are attacked by the *C. fimbriata* complex. Eight hosts in particular, have been identified as being as highly susceptible to multiple genotypes of the pathogen, these are:

1. Mango.
2. Eucalyptus sp. and their hybrids.
3. Pomegranate.
4. *Acacia* spp.
5. Edible figs (*Ficus*).
6. Taro and other *Araceae* family.
7. *Crolotaria* (genus of herbaceous plants & woody shrubs).
8. Kiwifruit (*Actinidia* sp.).

Biology and Epidemiology

Ceratocystis fimbriata is a complex of soil-borne fungal pathogens, which cause wilt disease in a number of plant species, including kiwifruit (*Actinidia*), by compromising the vascular system. The *C. fimbriata* complex has a wide and unpredictable host range, both as a simple wound coloniser and as an aggressive plant pathogen. In the past 15 years, new host crops and new epidemics of *Ceratocystis* wilt have been reported worldwide, especially in Brazil and Asia.

Habit and Distribution

Ceratocystis fimbriata colonizes wounds and lives necrotrophically on a variety of herbaceous and woody plants, causing wilt diseases, stem cankers, root rots, and vascular discoloration. The pathogen may cause only a local infection or it may cause the death of the entire plant. *C. fimbriata* is an early colonizer of plant wounds but may be quickly overtaken by saprophytic fungi, especially some basidiomycetes (Grosclaude *et al*. 1990). Because it produces thick-walled aleurioconidia, the fungus may survive extended periods or for shorter periods in water (Grosclaude *et al* 1991). The importance of the soil-borne phase of *C. fimbriata* remains largely unexamined. The fungus lives in both tropical and temperate environments and has caused serious epidemics on cacao plantations in Latin America (Iton, 1959), sycamore street trees in Italy (Panconesi, 1981), and almond orchards in California (De Vay *et al*. 1968). The temperate strains of *C. fimbriata* (those attacking stone fruit trees, hickory, etc.) appear to have developed in North America. Latin America seems to be a site of diversification for the tropical strains of this fungus (Harrington, 2000).

Insect Relations

Ceratocystis fimbriata produces a fruity odor that is assumed to be attractive to various scolytid and nitidulid beetles that are associated with the fungus. On cacao, *Xyleborus* spp. (Scolytidae) selectively attack trees infected with *C. fimbriata*, and the insects and fungus are sometimes described as a disease complex (Iton 1966). *Xyleborus* beetles preferentially attack diseased cacao trees, especially preferring trees with deteriorated bark (Saunders, 1964). The adult female beetles bore into the tree perpendicular to the bark, usually at the base of the trunk. Branching tunnels in which eggs are laid form horizontally planar "galleries." *C. fimbriata* and other fungi may live within the galleries (Iton and Conway, 1961).

Management Strategies and Tactics

Wound avoidance is key to management of some diseases caused by *Ceratocystis* spp.

Ceratocystis spp. have been frequently introduced to new areas by human activity, and international quarantines have been considered or are in place. Infected planting stock (especially rooted cuttings or grafted scions) is the most likely pathway of introduction, but restrictions on the movement of such stock are should be there (Harrington, 2013).

Complete eradication of an exotic *Ceratocystis* sp. from even a limited area is a difficult task, but local introductions may be eliminated if recognized quickly, and sanitation practices have proven effective in managing local epidemics (Harrington, 2013)

Reduction in the root graft transmission of the oak wilt pathogen by the use of root-free zones has been practiced for many years and can be highly effective in reducing losses

Generally, a trench is made to delimit infected from healthy trees.

As with the management of most forest diseases, an integrated approach involving several strategies is necessary to control diseases caused by *Ceratocystis* spp., especially in urban settings.

Disinfection of pruning and grafting tools may help control *C. fimbriata* diseases in *Plantanus*.

Eradication of wilt infected plants has been advocated for the management of pomegranate wilt due to *C. fimbriata*.

Soil drenching around the infected and surrounding healthy plants or of the entire orchard with propiconazole (0.1%) + boric acid (0.5%) + Phosphoric acid (0.5%) (Sharma *et al*., 2010).

The insecticide chlorpyriphos (0.2%) can be used to control shot hole borer and other insect infestations which have seldom been found associated with wilt infections.

Wilt infections in soil having shot hole borer and *C. fimbriata* infestations can be managed by soil application of chlorpyriphos (0.2%) along with carbendazim (0.2%) or propiconazole (0.2%) (Sharma *et al*., 2010).

Soil sterilization with formalin (0.2%) prior to replanting also control wilt disease.

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Application of Robots in Agriculture

Article ID: 35033
Kalpana M[1], Sumathi C S[2]
[1]Associate Professor (Computer Science), Anbil Dharmaligam Agricultural College and Research Institute, Tiruchirappalli.
[2]Associate Professor (Computer Science), Agricultural Engineering College and Research Institute, Tiruchirappalli.

Introduction

Agriculture is one of the important fields which cover the major portion of a country's growth. The growth of human population is at supersonic speed and predication says that population would reach around 9 billion in 2050. As that of human population growth agricultural production has to be increased to cope up the need of humans. So, the farmers are in need of assistance from the robotic world.

Robots in Agriculture

Agricultural robots are very handy to perform repetitive and automating work to the farmers which may improve the yield. The common works are assisted by robots. They are:

1. Weed control
2. Soil analysis
3. Phenotyping
4. Automated seeding, pruning, mowing, spraying etc.,
5. Harvesting and picking
6. Sorting and packing
7. Monitoring the environment

Caring of crops and harvesting is the most important activities where robots are used. Visual robots are used to know the sufficient space between the seeds and to ensure the fastening of growth. The huge field are monitored by robots.

It helps in preventing loss in the field due to weeds. Robots helps in reducing waste water for specific crops. Ground robots are navigated through each row of crops and watered at the ground level of each crop. Man power are reduced in agriculture field by using robots. A single robot works equivalent to 30 human workers, which helps in saving time and increase the crop yield of farmers.

Advantages of Agriculture Robots

1. Error can be reduced with higher speed and closer tolerance level.
2. The robots don't get tired, sick and the time off is not needed.
3. The results are with higher velocities and higher quality.
4. Robots reduces the use of pesticides up to 80% in farm.
5. Robots are efficient to work in rocks, ponds, trees and obstacles very easily.
6. With robots the products can be delivered with high quality and lower cost.
7. Robots are used in mechanical spraying, weeding and mowing.
8. Robotic cameras and sensors helps in detecting weeds, stress, identify pests, parasites and other diseases.
9. Robots replaces human operators with good return on investment with effective solutions.

Disadvantages of Agriculture Robots

1. Robots are costlier and needs lot of money.
2. Maintenance is required for perfect operation of robots.
3. Many farmers may lose their jobs.
4. Robots change the culture and emotional appeal of agriculture.
5. Farmers with lower grade cannot access robots.

Conclusion

In recent trends robots are used in agriculture. They help to increase the yield of farmers. Harvesting and picking robots became popular among farmers. Agricultural robots assist in repetitive, slow and dull task of farmers, helps them to focus on overall production. Robots have many benefits for the agricultural sector, including a lower production cost, higher quality of fresh produce, and decrease the need of labour.

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Estrous Induction in Dairy Animals

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Rameez Ali[1], Anees A Shah[1]
[1]Mountain Livestock tresearch Institute, Manasbal, Ganderbal-193504.

Abstract
Estrus cycle is a rhythmic change that happens in the reproductive system of female animals beginning with one estrus stage to the next. The ordinary span of estrus cycle is 21 days in cow, sow, and female horse, 17 days in ewe, and 20 days in doe. Although cattle go through estrus consistently, however, this cyclic activity is affected by many factors leading to conditions like anestrum. Ovarian cyclicity can be induced using various managemental factors, hormones, drugs and ayurvedic components.

Introduction
From the ancient ages, the animals have been an important piece of human life. With the passage of time, the reliance on these animals is increasing day by day. Although, animal population all through the world is contributing in accomplishing the worldwide food security. Yet, the quick blast of human population which is projected to be almost 9.7 billion inside 2050 has expanded the interest for animal products. Along these lines, experts are being focused toward getting more production from the animals. The significant obstructions toward this objective are the various illnesses and shortage of animal feed particularly in lacking or non-industrial nations. Among the few sicknesses, issues related with animal reproduction have consistently involved incredible worry for the producers. The female animals having a reproductive issue can't be imagined and produce posterity. The major reproductive issues incorporate anestrus, repeat breeding, delayed estrus, various infections, and so on. Among them the issue of anestrus has an occurrence pace of 2.13–67.11% in the bovine population of a nation like India which is the biggest producer of milk (Kumar *et al.,* 2014). Anestrus is a condition when there is nonappearance of standard reproductive cyclicity in the females. Therefore, the animal gets useless and causes an immense efficient misfortune to the farmers and producers. As of now, there are a few set methodologies which can prompt estrus in anestrus females by incorporates practices like administration of hormones to the utilization of bio stimulation. These estrus inducers can be isolated into two sections, that is, non-hormonal and hormonal. Non-hormonal medicines incorporate plant-determined heat inducers, mineral supplementation, uterine and ovarian massage, and utilization of Lugol's iodine. The hormones that are utilized in estrus induction are estrogen, progesterone, GnRH, prostaglandin, insulin, and anti-prolactin-based treatment.

Non-Hormonal Methods
1. Plant derived heat inducers: Diverse plant extracts are being utilized for the treatment of anestrus traditionally. A few estrus-initiating natural medicines are accessible in Indian market. The adequacy of estrus-instigating preparations like Prajana, Janova, Estrona, and Sajani is grounded (Pugashetti *et al.,* 2009). These can be applied in post pregnancy anestrus, and other issues. In spite of the fact that they can instigate estrus in crossbred cows, the conception rate remains unaltered.

2. Mineral supplementation: Minerals have a significant part in the reproduction, and their insufficiency can cause a few conceptive issues. Deficiency of calcium is exceptionally basic in post pregnancy dairy cattle (Ali *et al*., 2012a). Any change in Ca:P proportion can influence the pituitary emission and consequently ovarian activity resulting in the delay in puberty, irregular estrus, and so on. Other minor elements like zinc, selenium, cobalt, iodine, chromium, and so on additionally have a conspicuous job in the proliferation of domestic animal reproduction

3. Uterine and ovarian massage: It is the most conservative strategy for the treatment of anestrus. In this technique, delicate massage of the uterus and ovary is done per-rectally (Ali and Shukla, 2013). It increases blood flow on the surface of the ovary and incitement of ovarian intrinsic variables.

4. Lugol's iodine: Intrauterine use of Lugol's iodine can adequately initiate estrus in cattle and buffalo. It shows a great conception rate with cost-adequacy. It acts as uterine irritant and increase blood supply there. It can likewise invigorate hypothalamus for the secretion of GnRH, and in this way the conceptive cycle is recovered (Pandey *et al.,* 2011).

Hormonal Methods

1. Estrogen: Administration of estrogen can assist the animal to come into estrus (Ali *et al.,* 2012b); however, it might sometimes be anovulatory. Estrogen advances the ovulation through LH surge as estrogen shows a positive impact toward the pituitary. Utilization of estrogen is restricted these days due to its side effects as it can cause cystic ovary and increases peristalsis of the oviduct.

2. Progesterone: Progesterone is emitted from the corpus luteum in an ordinary estrus cycle. With the decrease in the progesterone level, the follicles begin developing. A similar circumstance can be impersonated remotely. Progesterone can be regulated remotely for a certain term, and its withdrawal can cause induction of estrus. Several intravaginal progesterone-delivering gadgets are accessible. It incorporates CIDR (controlled inward drug discharge), PRID (progesterone-delivering intravaginal gadget) etc. Ear implants of progesterone are also available. These devices are for the most part utilized for 7–9 days and can be used with different hormones like GnRH, PGF2α etc. (*Ali et al.,* 2012c).

3. GnRH: GnRH and its analogs can be effectively used to initiate estrus in animals. It initiates ovulation, if mature follicle is available by instigating the LH surge. GnRH can improve conception at the planned artificial insemination after estrous synchronization with PGF2α (Alyas *et al.,* 2013). GnRH given after PGF2α may improve fertility through its direct or indirect (by means of LH secretion) activity on the ovulatory follicle.

4. Prostaglandin: For persistent corpus luteum and subestrus, PGF2α is the treatment of choice (Ali and Shukla, 2013). Effective treatment of silent estrus in cattle and buffalo can be possibly achieved by the administration of natural or synthetic PGF2α with single dose and at reasonable degree. PGF2α is only successful between days 6 and 16 of the cycle and in the presence of active corpus luteum.

5. Insulin: Empowering results have been found in the utilization of insulin for induction of estrus in animals either alone or combined (Gupta *et al.,* 2010). Insulin improves the follicular development in true anestrum.

6. Anti-prolactin: Summer anestrus in buffalo could be expected due to hyperprolactinemia, with this presumption bromocriptine, an anti-prolactin drug has been utilized with beneficial effects (Verma *et al*., 1992).

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Food Flavor and Flavoring Compounds Present in Plant Foods

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Anjali Yadav[1], Usha Singh[2]

[1]Research Scholar, Department of Food and Nutrition, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, BIHAR – 848125.

[2]Professor cum Chief Scientist, Department of Food and Nutrition, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, BIHAR – 848125.

Introduction

Flavour is the sensory phenomenon which is a combination of all sensation of taste, odour or aroma, heat and cold, texture or mouth feel. Appearance of food is important, but it is the flavour that ultimately determines its quality and acceptability. While the taste of food is sweet, sour, bitter, salty and the fifth and latest one is umami. The primary role of flavour in food processing is to make the food palatable. Many food items can be made consumable with the addition of flavours which increases the functional and economic value of food.

1. Smell: Smell are sensations that result when specialized nerve receptors in the mouth and nose detect the molecules.

2. Taste: The sensation of flavour perceived in the mouth and throat on contact with a substance. Taste is the sensory function of the central nervous system. The basic tastes are sweetness, bitterness, sourness, saltiness, umami (savoriness).

a. Sweetness: Sugars are used more to impart sweetness flavour to food. Fructose present in honey is the sweetest sugar followed by sucrose and glucose, whereas lactose in milk. Natural sweet compounds are generally polyhydroxy compounds with a straight chain structure such as sugars and hexahydroxy cyclic alcohols mannitol and sorbitol

b. Bitterness: The bitter taste is perceived by many to be unpleasant sharp or disagreeable. Common bitter foods and beverages include coffee, beer, bittermelon, citrus peel etc. These are due to alkaloids, glycosides other classes of organic compounds as well as inorganic salts. Narigin the bitter principle of grape fruit, amygdalin a glycoside presents in bitter almonds, horseradish contains the alkaloid sinigrin, caffeine is the constituent of coffee and tea. Quinine, stychine, nicotine etc. are also bitter alkaloids.

c. Sourness: Sourness of food is due to the presence of organic acids of which citric, tartaric and malic acid are most common one. Sourness is the taste to detect acidity. It is remarkable that hydrogen ion is mainly responsible for sour taste. Except oxalic acid, all the other acids are weak acids are the degree of sourness.

Saltiness: It is most readily detected on the sides and tip of the tongue. Sodium chloride is the only salt that has a pure taste, beside imparting flavour it is also an essential nutrient. Besides the tendency to stimulate flavours salt tends to decrease the sweetness of sugar to enhance the flavour required in many confectionery products. Salts have different tastes e.g.; some iodides and bromides are bitter whereas some salts of lead and beryllium are sweet.

Umami: Umami (Japanese term) or "savory" flavourants more commonly called taste or flavour enhancer are largely based on amino acids and nucleotides. Four taste receptors are there but fifth have been characterized and that for the meaty taste for MSG (monosodium glutamate) when added to food called Umami. Levorotatory (L) form of MSG fits precisely at the binding site of the receptor taste bud. Umami is "delicious taste", but it also carries the implication of meatiness, savoury, or broth-like. Glutamic acid in the form of MSG is naturally present at low levels in the muscle tissue of live animals, but the higher concentrations in meat are mainly derived from the protein breakdown that occurs during the post-mortem ageing process.

Flavouring Compounds

The substance mainly responsible for the aroma of food products are volatile compounds. These may be aliphatic esters, aldehydes or ketones are present in fruit and other natural foods in very low concentration. Some of the important groups of flavouring compounds are as follows:

Flavonoids: These are responsible for the flavour of many fruits e.g., orange, lemon and grapefruit peels contain a number of flavanone glycoside. Among this hesperidin (orange and lemon) and naringenin (grapefruit) are most common one.

Terpenoids: They are major components of citrus oils and contribute to the flavour of citrus fruits. Limonene, a monoterpene hydrocarbon possessing a lemon- like odor constitutes 90% of most citrus oils.

Sulphur compounds: Certain volatile sulphur containing compounds possess powerful and distinctive odors which contribute to both pleasant and unpleasant aroma of many foods e.g. vegetables belonging to the genus Allium (onion and garlic) and Brassica (cabbage, cauliflower, Brussels sprouts and broccoli).

Flavour Production from Plant

Plant	Components/Flavour
Strawberry	Monoterpenes
Allium sativum	Garlic
Allium cepa	Onion
Theobromo cocoa	Cocoa
Oryza sativa	Basmati
Malus silvestris	Apple aroma
Isoamyl acetate	Banana
Methyl anthranilate	Grape
Allyl hexanoate	Pineapple

Conclusion

Flavour is the sensory impression of a food or other substance and is determined mainly by the chemical senses of taste and smell. The trigeminal senses which detect chemical irritants in the mouth and throat as well as temperature and texture, are also very important to the overall gesalt of flavour perception. Therefore, different favouring compounds are present in plants which attract the people to consume.

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Cole Crops Diseases and their Management

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Shivani Chaudhary[1]
[1]Ph. D. Scholar, Department of Plant Pathology, S.V.B.P.U.A.T., Meerut, U.P.

Cole crops include broccoli, cabbage, cauliflower, mustard, turnips, radishes etc. They are eaten for their nutritive benefits because they are high in vitamins A and C, carotenoid, dietary fibers, calcium, iron and magnesium. Numerous diseases are initiate in cole crops. But just rare diseases occur on a sole plant in each season. Before planting it is good to know that which disease may occur in that area and at which time and accordingly the selected techniques and crop varieties that mitigate the effect of major diseases are applied. It is essential to know where a pathogen initiates, how it scatters and contaminates agricultural plants, and what environmental conditions encourage disease progress.

Damping-Off

The causal organisms for this are *Rhizoctonia solani* or *Pythium spp.* which is the source of seedling diseases. Root or stem rots are also caused by *Phoma spp.* and *Phytophthora spp*. *Pythium* is also accomplished of producing seed rot. Damping off and *Pythium* seed rot are supplementary mutual in cool and rainy environments, whereas *Rhizoctonia* flourishes in hot soil environment. It occurs later when seedlings grow but formerly, they appear from the soil. Most commonly lesions are visible at or close to the soil's surface. Plants become black and shriveled the tissues collapse and the plant tumbles downs and dies. Generally, cole crops seedling lives for some time and then grows, but the exaggerated area will not blowout, giving birth to wirestem which is a spiny condition, those seedlings are not be relocated. It occurs anyplace in a field or seedbed, but mainly with high green organic matter with deprived drainage and compressed soil. Over-watering or over-crowding of seedlings emphasizes the disease. Plants are not susceptible after the third- or fourth-leaf stage.

Management:

a. Apply treated seed with appropriate fungicides.
b. When the soil is cold the planting should be avoided.
c. Quick germination and vigorous growth is shown when good quality seed bed is prepared.
d. Removal of debris and residues.
e. Sow finely on raised beds to recover aeration and soil drainage.
f. Practice good water management, so that the soil is not over wet.
g. Drench the seedbeds with an appropriate fungicide as a preventative measure.

Clubroot

The causal organism is *Plasmodiophora brassicae.* It is a serious disease that disturbs many cruciferous plants. It can live in the soil for numerous years and flourishes in acidic soils with adequate rainfall. It spreads from one field to another due to the movement of diseased plants, as well as the contaminated soil on equipment and surface water overflow. It is also spread by the animals through their excreta as they have fed on the infected plant. Plants might have been infected for some time before showing signs of stress. The initial symptoms are usually a slight drooping of leaves during the day, followed by retrieval at night, and then obstinate wilting later. Infected plants are generally smaller than healthy plants. Roots are engorged into countless shapes. Numerous infections on the same root cause the swelling and incongruous alteration that illustrate the disease. Such roots snap and are attacked by different organisms causing the roots to decay.

Control: If it persists in the soil then there is no economical way to eliminate the disease. So, disease stoppage is the only answer.

a. To stop contamination of clean fields by washing the equipment’s.
b. Avert water flow from infected to clean fields. Growing transplants in disinfected beds; young plants can be infected for some time before showing symptoms and cannot always be identified at transplanting.

c. Seedlings irrigated with contaminated water can become infected so disease free water source is used.
d. Clubroot spores do not develop healthy in alkaline soil, so liming may aid decrease disease incidence.
e. Two- or more year crop rotation with cereal, can evidently lessen clubroot incidence.

Fusarium Wilt or Cabbage Yellows

The causal organism is *Fusarium oxysporum* f. *conglutinans*. This fungus is skilled in abolishing delicate cabbage varieties, as well as kohlrabi and kale While broccoli, brussels sprouts, and cauliflower are not damaged. In summer, the disease is extremely severe, where minor symptoms are shown in cabbage. It develops the efficiently in temperatures ranging from 24°C to 29°C, with slight growth happening below 15°C. The fungus may live in the soil forever, even during lengthy duration of high temperature and drought. The fungus blowouts by infected plants and dirt on equipment, drainage water and footwear. Once in a field it is disseminated through cultivation and other practices.

Control:

a. Use of resistant cultivars.
b. Grow cabbages in winter, when disease expansion is measured.
c. Growing transplants in disease-free soil or fumigated soil.
d. Alternate between nonhost crops like tomatoes or lettuce, to decrease accumulation of the fungus in the soil.
e. Avoid diseased soil or plant remains from contaminating clean fields.

Black Leg

The causal organism is *Phoma lingam*. This fungus shows an array of symptoms including seed rot, damping-off, stem and root rot, and leaf lesions. Characteristically, stem rots commence at or beneath ground level, as black leg affects the lower stem and roots, aggrieved plants are often tiny and wilted. The most obvious signs of black leg appear on the basal end of the stem and soil surface. The rot is tan colored, semi-dry with blackish coverings and minute black pycnidia on the surface. When the xylem is sliced through it has black center. Cold and wet conditions are beneficial for the disease. It is disseminated by seed or live-in soil in plant debris.

Control:

a. Rotate infected fields with non-cruciferous crops for at minimum two years.
b. Use disease-free planting materials or hot water treatment is applied for the seeds.
c. Seedbeds are fumigated.
d. Infected debris are ploughed under the soil.

White Blister or White Rust

The causal organism of the disease *Albugo candida*. White blister is a sporadic disease, but many cruciferous plants are affected. On the lower surface of leaves elevated white pustules are formed, while on the upper side yellow spots are formed. Sometimes greenish tint is found in pustules, but are generally pure white which has been speckled onto exaggerated parts. These pustules are recorded on broccoli heads; infected sprouts are white and are stirred to grow very hefty, with approximately some malformation. Under favorable conditions that is cold and moist, the disease spread and progress is rapid.

Control:

a. Treating seedlings with fungicides is worthwhile where contaminations occur.
b. Water management can decrease the frequency of the disease.
c. Seedbed soil is fumigated.
d. Seedbed should have good aeration and drying.
e. Avert over-lapping of plants and ploughing in old crops.

Black Rot

The causal organism of black rot is *Xanthomonas campestris* pv. *campestris*.

This disease is bacterial and can be very damaging under rainy, humid and in warm conditions. The more harshly affected are the summer crops. Increasing the application of sprinkler irrigation in dry areas, and recurrent reaping with crucifers, have instigated it to become more predominant. Broccoli is less affected. Primarily, yellow to light brown patches appear at leaves margins, then a web of black veins forms inside these areas. Exaggerated areas turn brown and dry out, making triangular shaped lesions on the margin of leaves. The pathogen blowouts from the margin to leaf blade that shortly become necrotic. The older, infected leaf drop is common. The bacteria move into the foremost veins and vascular system, making the tissue brownish black. Plants may die or remain stunted if they are affected at the seedling stage. The entry of bacteria in plant is through natural openings at the margins of the leaves or through wounds caused by insects.

Control:

a. Use of lenient cultivars.
b. Confirm that the seed is disease-free.
c. Three-year crop rotation is applied.
d. Control of weeds.
e. Deep plough is done to bury all diseased plant material.
f. Rise the intermission between irrigations.
g. Dodge sprinkler irrigation if it is possible.
h. Avoid raising crops over long periods where circumstances favor disease progress.

Soil Test Crop Response – Concept and Methodology

Article ID: 35037
Nidhi Luthra[1], Pooja Nain[2]
[1]Ph.D. Scholar, Soil Science and Agricultural chemistry, ICAR-IARI, New Delhi, 110012, Delhi.
[2]Ph.D. Scholar, Soil Science, GBPUA&T, Pantnagar, 263145, Uttarakhand.

Soil testing is the chemical analysis of soil and is recognized as a scientific means for quick characterization of the fertility status of the soil and predicting the nutrient requirement of the crop. Once the fertilizer is recommended, due to the high cost of fertilizer and keeping in view the soil health, it becomes necessary that every unit of fertilizer should be used judiciously. For this very purpose,AICRP on soil test crop response (STCR) started in our country in 1967.

Objectives of STCR

1. To develop relationships between soil test values and crop response to fertilizers in order to provide calibration for fertilizer recommendation based on soil testing.
2. A basis for making fertilizer recommendations for targeted yield.
3. To evaluate various soil specific soil test methods.
4. To evaluate joint use of chemical fertilizers and organic manures for enhanced nutrient use efficiency.

Methodology

Agarwal and Ramamoorthy (1978), found a significant linear relationship between yield of grain and uptake of nutrient. It implies that for obtaining a specific yield, a definite quantity of nutrient must be taken up. This value (FERTILIZER DOSE, FD) can be determined by the magnitude of expected yield target (qt/ha) and nutrient required to produce unit quantity of that yield i.e., NR (kg/qt). once it is known, the fertilizer can be calculated by taking the account of efficiency of soil nutrient (Cs %) and efficiency of fertilizer (Cf %) from available soil nutrient i.e., soil test value (STV).

$$FD = \frac{NR \times 100 \times T}{Cf} - \frac{Cs}{Cf} \times STV$$

Ramamoorthy etal indicated that such type of recommendations not only take into account the relationship between the nutrient of the soil and fertilizer sources but also among the nutrients themselves. Thus, this approach ensures nutrients to the plants in a real balanced state.

Achievements

1. District wise applicability of fertilizer prescription equations have been documented and transferred to DAC&FW.
2. Developed fertilizer prescription equations for different yield targets based on resource availability of the farmers.
3. Developed STCR-IPNS based fertilizer prescription equations.
4. Developed district wise nutrient plan for 10 states based on GPS/GIS based soil fertility mapping.

Thrust Areas

1. STCR recommendations for drip fertigation.
2. Fertilizer prescription equations for dryland crops, hi-value vegetables and floriculture.
3. DSS integrating GPS/GIS- based soil fertility maps with STCR prescription equations.
4. Contribution of non-exchangeable-K.
5. Nutrient plan for 173 districts.
6. Prediction equations for cropping sequences.

Conclusion

STCR has developed fertilizer prescription equations without IPNS for 23 field crops, 10 vegetable crops, and 2 medicinal crops. And with IPNS 38 field crops, 29 vegetable crops & 12 medicinal crops. This programme has conducted 130 field demonstrations on oilseed crops and 150 field demonstrations on other crops on farmers field in different states to popularize STCR based fertilizer recommendations and providing benefits to farmers.

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Viral Diseases of Tomato

Article ID: 35038

K. Sairam[1]
[1]PhD Scholar, Department of Plant Pathology, College of Horticulture Anantharajupeta, Dr. YSR. Horticultural University.

Tomato Spotted Wilt

Causal Organism: Tomato Spotted Wilt Virus (TSWV), Groundnut bud necrosis virus

Symptoms:

a. Symptoms vary among hosts and in a single host species.
b. Stunting is a common symptom of TSWV infection. It causes streaking of the leaves, stems and fruits.
c. Chlorotic or necrotic rings form on the leaves of many infected hosts.
d. Fruits show numerous spots about one-half inch in diameter with concentric, circular markings.
e. Pale red or yellow areas with concentric circular marking in the normal red skin of ripe tomato are formed.
f. Discoloration of seed. Thickening of veins and **bronzing** of young leaves.
g. Growing tips may die-back and terminal branches may be streaked.
h. Affected plants may have a one-sided growth habit or may be entirely stunted and have drooping leaves.

Mode of spread and Survival:

a. The spotted wilt virus is transmitted through thrips, *Frankliniella schultzii, Scirtothrips dorsalis, F. Occidentalis* and *Thrips tabaci*).
b. Adult thrips transmit the disease, only when the larvae acquire the virus from infected plants.

Management:

a. Removal and destruction of infected plants & weed hosts**.**
b. Vector control with dimethoate (Rogor) or methyl demeton at 10 days interval**.**
c. Growing *Crotolaria juncea* as a barrier crop reduces vector migration**.**
d. Spraying of sorghum or coconut leaf extract.

Tomato Mosaic

Causal Organism: *Tomato mosaic virus*

Symptoms:

a. The disease is characterized by light and dark green mottling on the leaves often accompanied by wilting of young leaves in sunny days when plants first become infected.
b. The leaflets of affected leaves are usually distorted, puckered and smaller than normal.
c. Sometimes the leaflets become indented resulting in "fern leaf" symptoms.
d. The affected plant appears stunted, pale green and spindly.
e. The symptoms vary depending on the strain of the virus. Some strains cause yellowing or leaf mottling which may also affect the fruit.
f. Some other strains produce **streak symptoms** consisting of longitudinal necrotic streaks on stem or petioles.
g. Such diseased plants are killed **Necrotic sunken lesions also appear on fruits** and sometimes internal necrosis or browning of mature fruit occurs.
h. The virus is spread by contact with clothes, hand of working labour, touching of infected plants with healthy ones, plant debris and implements.

Mode of spread and survival:

a. The virus is seed borne and upto 94% of seeds may contain the virus.
b. The virus infection occurs during transplanting. It is readily sap transmissible.

c. Many solanaceous plants are susceptible to tomato mosaic virus.
d. The virus is spread easily by man and implements in cultural operations or by animals and by leaf contact. Infection is through roots.

Management:

a. Seeds from disease free healthy plants should be selected for sowing.
b. Soaking of the seeds in a solution of Tri-sodium orthohosphate (90 g/litre of water) for 15 to 20 minutes prior to sowing helps to reduce the disease incidence. The seeds should be thoroughly rinsed and dried in shade.
c. In the nursery all the infected plants should be removed carefully and destroyed.
d. Seedlings with infected with the viral disease should not be used for transplanting.
e. Crop rotation with crops other than tobacco, potato, chilli, capsicum, brinjal, etc. should be undertaken.
f. All collateral hosts in the vicinity should be destroyed before planting new crop.
g. Heat treatment for 2-4 days at 70^{0}C.
h. Cross protection of tomato seedlings by inoculating with mild strains (Zitter, 1991).
i. Field workers should avoid using tobacco products while working in the field.

Leaf Curl

Causal Organism: *Tomato leaf curl virus* (ToLCV)

Symptom:

a. Leaf curl disease is characterized by severe stunting of the plants with downward rolling and crinkling of the leaves.
b. The newly emerging leaves exhibit slight yellow colouration and later they also show curling symptoms.
c. Older leaves become leathery and brittle. The nodes and internodes are significantly reduced in size.
d. The infected plants look pale and produce more lateral branches giving a bushy appearance. The infected plants remain stunted.

Mode of spread and survival:

a. It is neither seed nor sap transmissible.
b. But seeds from fresh fruits having infection may have the virus on the seed coat.
c. The virus is transmitted by white fly, *Bemisia tabaci* and grafting. Even a single viruliferous insect is able to transmit the virus.

Management:

a. Keep yellow sticky traps @ 12/ha to monitor the white fly.
b. Raise barrier crops-cereals around the field.
c. Removal of weed host.
d. Protected nursery in net house or green house.
e. Spray Imidachloprid (Gaucho) 0.05 % or Dimethoate (Rogor) 0.05% @ 15, 25, 45 days after transplanting to control vector (Panagopoulos, 2000).
f. Use resistant variety ***Lycopersicon perurvianum,*** **Akara Ananya, Akara Rakshak, Akara Samrat.**

Agricultural Information Systems and its Applications

Article ID: 35039

Ingle S. G.[1], Rede G. D.[1]
[1]Teaching Associate, Department of Agricultural Economics, College of Agriculture, VNMKV, Parbhani, (M.S.).

Abstract

The present article is about the agricultural information systems and its applications. As we know agricultural information system is a system, in which agricultural information is generated, transformed, transferred, consolidated, received and fed back in such a manner that these processes function synergistically to support knowledge utilization by agricultural producers.

It empowers farmers to respond to different types of risk, market incentives and competition more efficiently. Thus, the importance of agricultural information systems for agricultural development and to identify the strength and weaknesses of the current systems and led to recommendations for improving their performance.

Introduction

India is essentially an agrarian society and basically depends on agricultural outputs. Agricultural information is an important factor that interacts with other production factors. Productivity of these other factors, such as land, labor, capital and managerial ability, can possibly be improved by relevant, reliable and useful information.

Therefore, essentially that the technology power should put greater stress on the transfer of scientific and technological information from the research institutes. New agricultural technologies are generated by research institutes, universities, private companies, and by the farmers themselves.

Agricultural information and knowledge delivery services (Demiryürek, K. 2010) (including extension, consultancy, business development and agricultural information services) are expected to disseminate new technologies amongst their clients (people who are involving in agriculture).

Farmers face new challenges due to lack of information on how to deal with the issues of climatic variability, market uncertainty, new technology etc. For example, farmer producing wheat on his field for generations now faces new changes of weather, temperature, soil moisture, soil quality, and biological factors.

This has resulted in emergence of new types of weeds, pests, and diseases (such as stem rusts) that can significantly affect the health, and thus yield and profitability, of the wheat crop. (Vayyavuru Sreenivasulu and H.B. Nandwana, 2001).

It is difficult for a farmer to find information on these new challenges from their conventional sources of information, to maintain or improve their yield. Farmers need to adapt to these challenges with information about the advanced techniques and methods that are relevant to their local environment. Information has an extensive and multifaceted role in agriculture.

Concept for Agriculture Information

Agricultural information is considered as a necessary input to agricultural education, research and development and extension activities. Different kinds of information are required by different kinds of users for different purposes.

The potential users of agricultural information include government decision-makers, policy-makers, planners, researchers, teachers and students, program managers, field workers and farmers. Figure 1 gives a design of the flow of agricultural information.

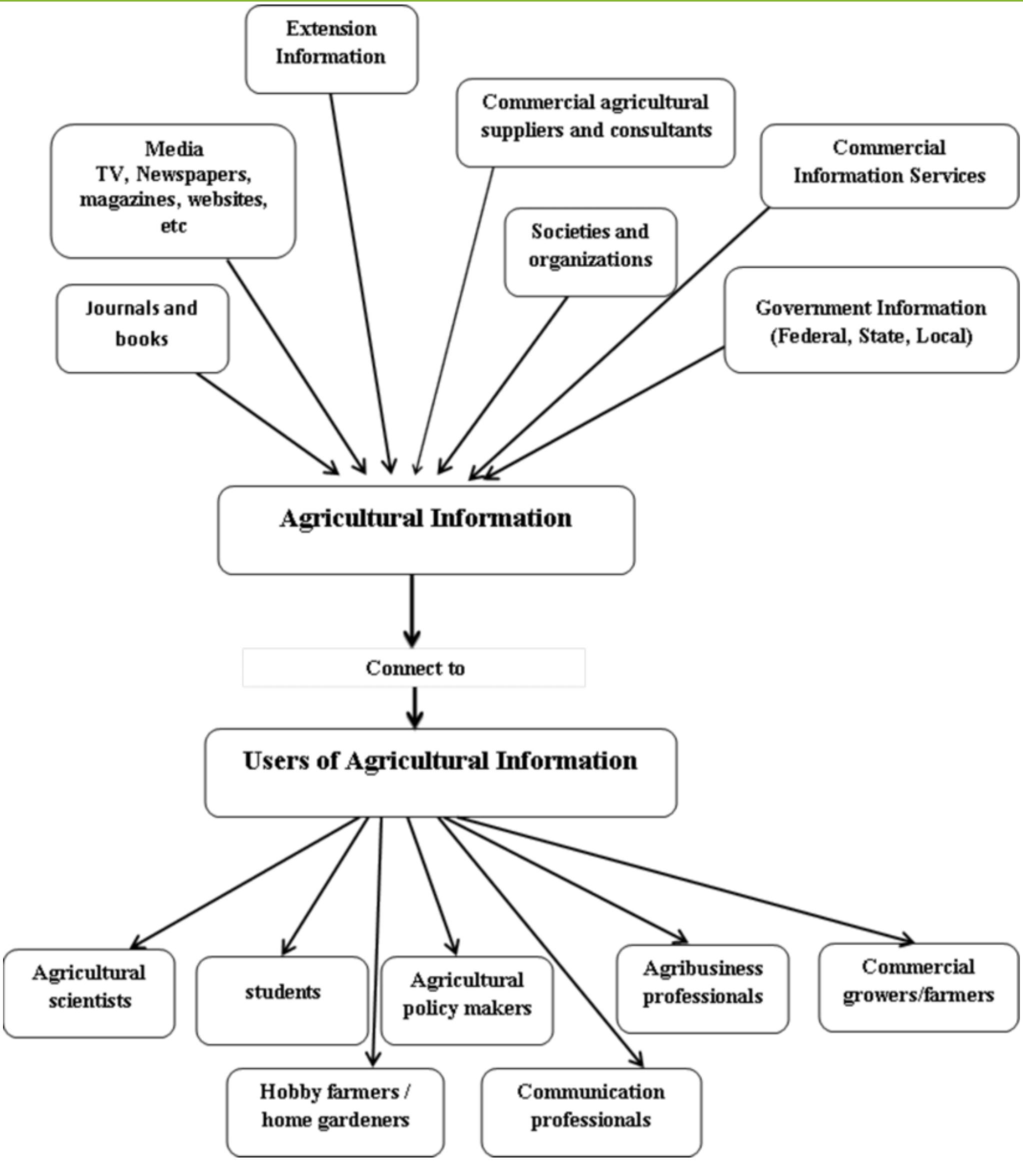

Fig. 1: Concept of map for Agricultural information | (Source: McCue *et al.*, 2005)

Agricultural Research Information System (ARIS) OF ICAR Now DMAI

It is essential that scientists in the Indian National Agricultural Research System (NARS) should have a quick access to and free exchange of information at local, national and international levels. NARS through its vast network of 30,000 scientists working at ICAR's 49 Central Institutes, 10 Project Directorates (PDs), 27 National Research Centres (NRCs), 86 All India Coordinated Research Projects (AICRPs), 261 KrishiVigyanKendras (KVKs), 29 State Agricultural Universities (SAUs), 120 Zonal Research Stations (ZRS), one Central Agricultural University (CAU), numerous (1000 plus) regional stations and other research centers has been catering to the agricultural research and information needs of the farming community. The ICAR during eight Five Year Plan embarked upon a project called Agricultural Research Information System (ARIS) to bring the power of information technology to the NARS. Its implementation started with the financial aid from World Bank under National Agricultural Research Project (NARP). The Directorate of Knowledge Management in Agriculture is committed to promote ICT driven technology and information dissemination system for quick, effectual and cost-effective delivery of messages to all the stakeholders in agriculture. Keeping pace with the current knowledge diffusion trends, Directorate is delivering and showcasing ICAR technologies, policies and other activities through print, electronic and web mode. Directorate is the nodal center for design, maintenance and updating of ICAR website along with facilitation of network connectivity across ICAR institutes and KVKs. Besides, Directorate provides public relation and publicity support to the council and its constituents across the country.

Agricultural Research Information System Network (ARISNET)

ARISNET has become an integral part of agricultural research, extension and education process. It links ICAR institutions and their regional research stations, central agricultural university, state agricultural university and their colleges, krishivigyankendras, zonal research centres with the ICAR headquarters. To exploit the potential of modem computing power in planning and management of agricultural research and scientific communication, ICAR started an Agricultural Research Information System Network (ARISNET) Basic guidelines to implement this project were provided by a team of experts from ICAR and International Service for National Agricultural Research (ISNAR). A phased implementation is recommended to create infrastructure for ARISNET, a national Wide Area Network for agricultural research with its headquarters at ICAR, New Delhi. ARISNET is being implemented in phased manner as indicated in the following Figure 2.

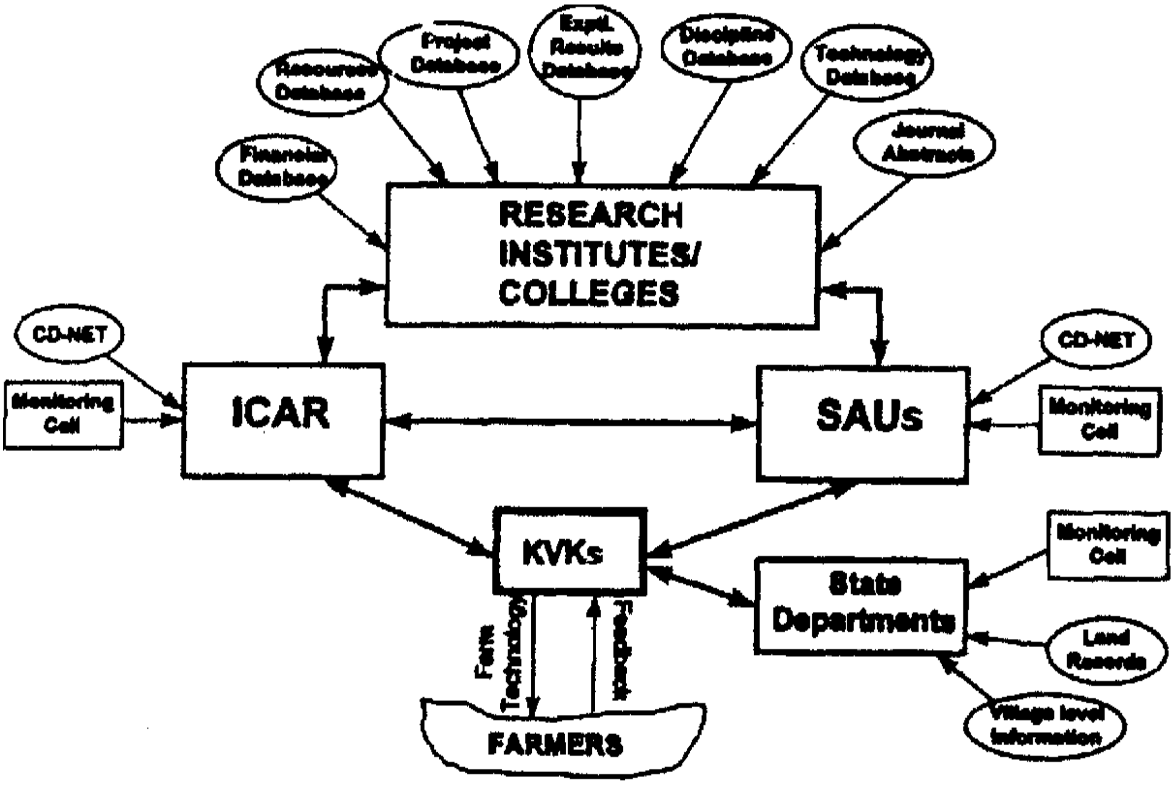

Fig.2: Agricultural Research Information System Network (ARISNET) | (Source: Singh, G. and K. Pal.1998)

Agricultural Marketing Information Network (AGMARKET)

The objective of this project is to improve prevailing agricultural marketing information system by minimizing the gap between generation and dissemination of market information. The major components of AGMARKET are the following: a) Establishment of computing facilities and networking b) Development of human resources c) Information transmission d) Development of database e) Portal on market information. NIC has tied BSNL to provide internet facilities at the AGMARKET nodes.

Strengthening of Informatics in the Offices and Field Units of the Department of Agriculture and Cooperation (DAC)-DACNET

The central sector project „DACNET" links the directorates, attached offices, subordinate offices, autonomous bodies and public sector undertakings and field units of the Department of Agriculture and Cooperation, Ministry of Agriculture. This project includes networking of field offices of DAC, connectivity, procurement of H/W, S/W tools, Application Software Development and training of officials. 4. Agricultural Extension Information System Network: VISTARNET- The four pillar of sustainable agriculture is Research, Education, Extension and Training. In order to make available the technology to small and poor farmers VISTARNET has been established for linking the extension functions at central, state and district level.

Infrastructural Facilities and Services Provided by NIC to the Ministry of Agriculture

These are as follows:

a. INTRANET/INTERNET.
b. Telecommuting programme.
c. Video conferencing d. Information Kiosk.
d. In-house training facilities.
e. Web site design and development.
f. Web enabled applications.
g. Information bulletin.
h. Intranet applications.
i. Agricultural portal.
j. NICNET based public information and facilitation centre.

Animal Production and Health Information Network (APHNET)

APHNET builds up reliable database and network-based information systems for all activities of the animal husbandry and dairying sector at district, state and national level, using NICNET facilities. As a part of APHNET, National project on Rinderpest Eradication (NPRE) which aims at capturing animal disease related information from various state Animal Husbandry Departments has been entrusted to NIC.

Market Information System for Horticulture

As part of the project, NICNET based internet/internet facilities have been established at National Horticulture Board (NHB), Computing facilities have been created at all market centres of the Board located all over the country. NIC has developed and implemented the necessary software for evolving a comprehensive database of the prices and arrivals of fruits and vegetables being received by NHB headquarters from market centres on a daily basis. This information is being used by the Ministry of Agriculture.

Integrated Fertilizer Management Information System (IFMIS)

The Department of Fertilizers (DOF) in collaboration with NIC has introduced computer-based methods for decision support and to evolve an evaluation International Journal for Research in Engineering Application & Management (IJREAM) ISSN: 2454-9150 Vol-05, Issue-01, April 2019 98 | IJREAMV05I0149028 DOI: 10.18231/2454-9150.2019.0261 © 2019, IJREAM All Rights Reserved. system which ensures a uniform system of planning and control mechanism with signaling system to highlight deviations from desired performance indicators by plants/organizations for all the public sector enterprises.

Computerization of Agricultural Census and Input Survey

Department of Agriculture and Cooperation collects and maintains agricultural statistics such as number, area, tenancy, land utilization, cropping pattern and irrigation particulars of different classes of operational holdings regularly and make it accessible timely to the planners and policy making for decision making. (R. Raj, S.2015).

A large database of about 8000 million bytes at national level and 1 GB at state level has been created. Agricultural Census and Input Survey database at DISTRICT/State/National level are procured and tabulated. Development and implementation of information retrieval system at micro and macro level for decision making at various levels are done also.

Users of Agricultural Information

User community varies greatly with their diversified need, educational, social, economic, physical and mental makeup. User community includes teachers, students(both PG and UG), scientists, research scholars, in one hand as well as progressive, small and marginal farmers, extension personnel, local shopkeeper (dealers of fertilizer, pesticides etc.), vegetable sellers in local market, persons engaged in nursery, bee keeping ,cattle &poultry farming etc. on other hand.(Babu, S.C *et a*l 2011)Agricultural stake holders include multinational companies, corporate sector, banking, community groups& NGOs, agricultural universities, technology companies and Government.

Nature of Agriculture Information and Problem

The problems of rural agricultural information during handling, storage, organization and dissemination are as follows:

1. Area specificity: Information is area or locality dependent. Like "formula Index" in chemistry, "Area/Locality Index" in Agriculture proved to be beneficial that surely provide right information to right user in right time.

2. Poor bibliographic Control: In developing countries like India Poor bibliographic Control of agricultural literature like technical reports, Internal research reports, lack of comprehensive and up to date lists hinder the availability of materials for acquisition by libraries Patents, standards played a significant role to research community but many libraries have no such records.

3. Lack of formal training: Trainings in rural agricultural information, documentation, and retrieval are considered to be essential both for information professional & user. Library professionals must be well acquainted with computer application as well as they must have some subject knowledge.

4. Confidentiality factor: Confidentiality of some agricultural reports limits their availability to the user without known them. Considering "Right to Information". A Vettorazzi (WHO expert) stated that Government report/official information on the adverse effect of pesticides is kept suppressed before the user community for reason best

5. Management problem: Suggested that management lack of appreciation of the importance of agricultural information centers in realizing parent institutions training needs and research objective is a major problem in developing countries.

Problem of Agricultural information in Indian Scenario

Following problems have been identified.

Farmer's problem is not undiscipline & simple.

a. Farmers adopt multidisciplinary holistic approaches to their work.
b. Spreads of new technologies are highly uneven across different agro climatic zone, situations
c. Farmer's problem is not undiscipline & simple.
d. Farmers adopt multidisciplinary holistic approaches to their work.
e. Spreads of new technologies are highly uneven across different agro climatic zone, situations depending upon diversity.
f. Gap between performance of research station &farmers field has proved highly persistent &latter situation is more complex, diverse & risk prone.
g. Introduction of state-of-the-art technologies accompanied by number of short- & medium-term negative effect as interrelationship between subsystems is functional.
h. Farmer's problem is not undiscipline & simple.
i. Farmers adopt multidisciplinary holistic approaches to their work.
j. Spreads of new technologies are highly uneven across different agro climatic zone, situations.

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Role of Intercropping in Soil Health Management

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V. B. Gohil[1], H. N. Chaudhary[1], H. A. Chaudhary[1], B. B. Vaghela[1], K. V. Chaudhary[1]

[1]C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar– 385506.

Introduction

The population of our country is estimated to cross over 1.29 billion in 2020 (Anon., 2020). This enormous demographic increase is creating unprecedented pressure on Agriculture sector to ensure food security, to fulfill this demand of crop production, priority action must be there to ensure that soils will cope with this increasing demand of food supply. The global soil resource is already showing signs of serious degradation (Banwart *et al.,* 2014) hence, restoration of soil quality is the major concern. Incorporating intercropping principles into an agricultural operation increases the production of greater yield on a given piece of land by making more efficient use of the available growth resources using a mixture of crops of different rooting ability, canopy structure, height and nutrient requirements based on the complementary utilization of growth resources by the component crops. Furthermore, soil health is benefited by increasing ground coverage with living vegetation, which reduces erosion, and by increasing the quantity and diversity of root exudates, which enhance soil fauna so, intercropping is one of the options to achieve the production aim along with sustaining soil health for the healthy ecosystem.

What is Intercropping?

Intercropping is the cultivation of two or more crops simultaneously on the same field. It also means the growing of two or more crops on the same field with a definite row arrangement *e.g.,* Maize + Green Gram (2:1) and Maize + Green Gram (2:2). Objectives of Intercropping Systems are to insurance against main crop failure under aberrant weather conditions or pest epidemics, increase in total productivity per unit land area and judicious utilization of resources such as land, labour and inputs.

Types and Definition of Intercropping?

1. Mixed intercropping: Growing two or more crops simultaneously with no distinct row arrangement.
2. Row intercropping: Growing two or more crops simultaneously where one or more crops are planted in rows.
3. Strip intercropping: Growing two or more crops simultaneously in different strips wide enough to permit independent cultivation but narrow enough for the crops to interact ergonomically.
4. Relay intercropping: Growing two or more crops simultaneously during part of the life cycle of each. A second crop is planted after the first crop has reached its reproductive stage but before it is ready for harvest.

Temporal Intercropping

Uses the practice of sowing a fast-growing crop with a slow growing crop, so that the fast-growing crop is harvested before the slow growing crop starts to mature.

			
Mixed intercropping	**Row intercropping**	**Strip intercropping**	**Relay intercropping**

Intercropping is Divided into Following Three Groups

1. Parallel Cropping: Two crops are selected which have different growth habits and have a zero competition between each other and both of them express their full yield potential *e.g.,* Green gram / black gram + maize and Green gram / soybean + cotton.

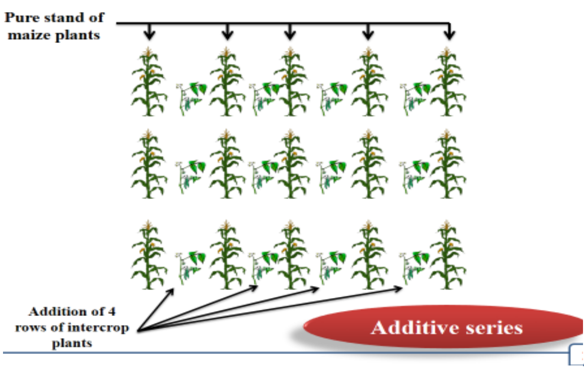
2. Companion Cropping: The yield of both the crops is equal to their pure crops. That the standard plant population of both crops is maintained *e.g.,* Mustard, wheat, potato, etc. with sugarcane and Wheat, radish, cabbage, sugar beet etc., with potato.

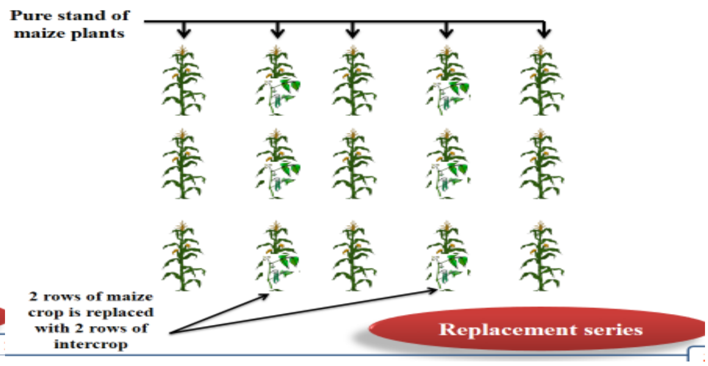
3. Multistoried Cropping or Multi-tire cropping: Growing plants of different height in the same field at the same time is termed as multistoried cropping. It is mostly practiced in orchards and plantation crops for maximum use of solar energy even under high planting density. *e.g.,* Eucalyptus + Papaya + Berseem and Coconut + Pineapple + Turmeric / Ginger.

Based on the Percent of Plat Population, Intercropping System is Divided into Two Types

1. Additive series: Mostly adopted in India one crop is sown with 100% of its recommended population in pure stand, which is known as the base crops. Another crop known as intercrop is introduced into the base crop by adjusting or changing geometry. The population of intercrop is less than its recommended population in pure stand. LER of additive series is greater than replacement series. Additive series is more efficient than replacement series in intercropping system.

2. Replacement series: Both the crops are called component crops by scarifying certain proportion of population of none component, another component is introduced. This type of intercropping is practiced in western countries.





Advantages of Intercropping

Additional yield and income per unit area and an insurance against failure of crops. Maintain the soil fertility with reduction in soil runoff and controls weeds. Provide shade and support to the other crop which utilizes resources efficiently and increase productivity. Intercropping with cash crops is highly profitable and helps to avoid intercrop competition and thus a higher number of crop plants are grown per unit area.

Sharma and Guled (2012) noticed significantly higher PEY, porosity, WHC, infiltration rate, bacteria count, fungi count, *Actinomycets* count and PSB count in pigeon pea + green gram (1:2) -set furrow + VC @2.5 t ha^{-1} which remained at par with pigeon pea + green gram (1:2) -set furrow. Roodagi and Itnal (2001) observed significantly higher cane yield and available N, P_2O_5 and K_2O (after harvest) in cane + sunnhemp (GM) which remained at par with cane + cowpea (GM), cane + soybean, cane + groundnut, cane + potato and cane + french bean. Soil organic carbon (SOC), Fe and Zn were reported maximum in cane + sunnhemp (GM).

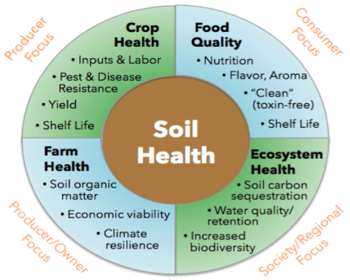
Disadvantages of Intercropping

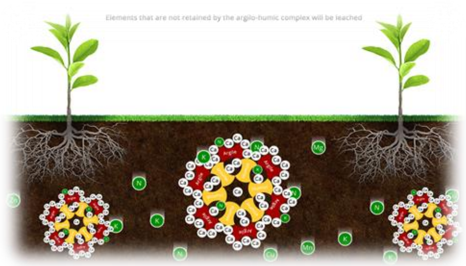
Yield decreases as the crops differ in their competitive abilities. Management of intercrops having different cultural practices seems to be difficult task. Improved implements cannot be used efficiently. Higher amount of fertilizer or irrigation water cannot be utilized properly as the component crops vary in their response of these resources.

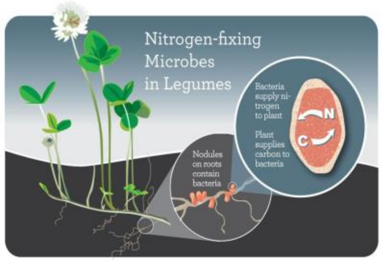
What is Soil Health?

Soil health can be defined as....

The continued capacity of soil to function as a vital living system within the ecosystem and land-use boundaries, to sustain biological productivity, promote the quality of air and water environments maintain plant, animal and human health. In general term that describes the ability of a soil to function food, crop, farm and ecosystems health is dependent upon **"Soil Health".**







Functions of Some Important Properties of Soil for Plant

Soil properties		Importance
Aeration	:	Roots require oxygen for respiration and nutrient uptake
Organic matter	:	The reservoir for nutrients
Soil pH	:	Regulates soil supply availability
Soil type	:	ability to store nutrients depend upon type of soil
Moisture	:	Needed to dissolve nutrients in order to be absorbed by roots
Micro organism	:	Breakdown organic matter to release nutrients
Bulk density	:	Low bulk density creates favorable physical condition
C:N ratio	:	Decomposition of organic matter

Basic Principles for Soil Health Management

The Nutrient removal by crops must be replenished in the soil and physical condition of the soil must be maintained. Humus level must be constant or increased with no increase acidity, alkalinity or toxic elements. Soil erosion must be controlled to rate of soil genesis.

Practices that Promote Soil Health

No till or conservation tillage, cover crops, diverse crop rotations, green manuring, organic manure and fertilizers, crop residue retention, intercropping with legume crops, integrated pest management and weed control by mulching and/or cultural practices.

Conclusion

From the foregoing discussion, it can be concluded that legume based intercropping systems play a vital role to improve soil health in terms of physical, chemical and biological properties to sustain crop production as compared to sole cropping system.

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Impact of Covid-19 on Agriculture and Global Economies

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Goodwill Nyaane[1], Uzma Manzoor[1]
[1]School of Agricultural Sciences, Sharda University, Greater Noida.

Introduction

Corona virus adversely affected globally. The actions executed to control the spread of the infection have disturbed business frameworks and schedules. These actions include physical distancing and lockdowns internationally. COVID-19 is not only a worldwide pandemic and health crisis but also affects the global economy and financial markets. Many reductions in income, unemployment, interference in transportation, services, manufacturing, etc., are the consequences of decreasing the economy. Covid-19 has significantly impacted Indian agriculture sector in the following ways

Earning Lower Prices for their Crops

From the beginning of the pandemic, some farmers have not been able to sell their crops properly. But some farmers report they can sell their crops but with the compromise on much lower prices, from which they can't even manage their household chores. It happened due to the postponement of transport systems, closure of markets and mandis, and closing of the country's borders.

Earning lower prices for their crops means that farming households have less income or not enough income to purchase food, children's education fees, and re-invest back in the farm and not enough amount to pay the debt from the bank.

Many Costs Have Risen, Including the Price of Food and Farming Supplies

Small farmers are experiencing many threats in this pandemic, low incomes and higher cost. They said that because of the low income, they are not able to feed their families properly. They are facing many severe problems in terms of starving.

Because of not having a proper supply chain, everything gets more expensive to purchase, such as fertilizers and seeds. According to them, demand increases and supply decreases, but its supply prices increase day by day. In this case, what they buy or what they eat.

Supply Chain Interference in the Restricted Movement of People and Goods

The COVID-19 pandemic presented unusual influences on food structures, food supply chains in farm work, preparing, transport and coordination, just as crucial changes popular. Food supply chains have shown exceptional flexibility despite these burdens. Supermarket holders have been renewing after some time, as accumulating conduct vanished and as supply ties reacted to expanded interest. The greatest danger for food security is done with there is no food availability. But with buyers' admittance, they have the fundamentals to keep away from an expansion in starving and food weakness.

Farmers May Become More Tense to Future Threats

Many small farmers or small households have difficult choices to cope with the destructive impacts of this pandemic. According to the farmers, they couldn't arrange funds in an emergency if they needed to. This result may cause their future to be threatened, they cannot even boost their food security, and they are not prepared for future challenges.

Smallholder farmers are a crucial part of the food value chain in India, as well as a critical element of the global food system. The COVID-19 pandemic has brought new risks that threaten livelihoods as well as food security. India is home to about 120 million smallholder farmers who contribute over 40% of the country's grain production, and over half of its fruits, vegetables, oilseeds and other crops. Much of the global share of food staples such as rice and wheat come from India, and almost half of the population in India depends on agriculture for their livelihood.

Conclusion

The COVID-19 crisis is not permanent, but it has magnified the vulnerabilities already present in the food system in India. An overall assessment of the issue can help governments and businesses create stronger, more resilient supply chains and measures to support smallholder farmers, who are critical to the food supply chain.

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Challenges in Street Foods: Food Safety and Consumer Protection

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Dhiraj Kumar Yadav[1], Khan Chand[2]

[1]Department of Food Engineering, National Institute of Food Technology Entrepreneurship and Management, Sonipat, Haryana, 131028, India.

[2]Department of Agricultural Engineering, School of Agricultural Sciences and Rural Development, Central University of Nagaland, Medziphema, Dimapur, Nagaland 797106, India.

Introduction

With the increasing population number, the demand for food and the cost of production also increased for many countries. The safety of food consumed every day has become the focal point for various concerned groups, it is quite valuable because they give high weight for food safety. In this sense, street-vendor meals serve an essential function as a source of food, nutrition, and employment, particularly in underdeveloped nations. Street meals are the "traditional fast food" of developing countries, as contrasted to the rising prevalence of "factory cookery" or "quick food" (Proietti et al., 2014). It is predicted that 2.5 billion people throughout the world consume street meals on a regular basis, owing mostly to its low cost and ease of availability (Forkuor et al., 2017). The majority of street foods are sold from carts or corridors on the pavements of busy streets in both urban and rural regions (Atinkut et al., 2018). Many studies have found that the potential advantages of street-vendor foods are restricted by difficulties in consuming street food safely.

Factors Affecting the Consumers' Choice of Street Food

The following five factors most commonly affect consumer preferences toward street foods.

1. Food quality
2. Price of food
3. Range of food
4. Atmosphere.
5. Speed of service.

Challenges

Although street foods bring undeniable benefits in terms of food security and socioeconomic development, increasing population and fast urbanisation in emerging nations cause environmental and food hygiene issues that affect street foods. Inadequate potable water supplies, as well as a lack of essential infrastructure and services, such as trash disposal and water delivery, may have a negative impact on street food networks (Rane, 2011). Some of the major challenges for food safety have been enlisted below.

1. Preparation and processing of street food in a hygienic way.
2. To overcome the health problems like chronic disease and obesity rate.
3. Due to continuous changes in working, social life, habits of dining out, and shortage of time, consumer's preferences are increasing rapidly towards fast food and other street foods than a traditional long meal. Therefore, quality and food safety are major concerns to maintain people's health.
4. Technique for packaging and storage of excess food.
5. Microbiological risk assessment of street food.
6. Consumer awareness on food safety norms.
7. Quality of raw materials: the raw material should be free from any type of contamination like non-food-grade chemical, pesticides, mycotoxins, etc.
8. Provide a waste disposal place and effective rubbish collection to minimise the accumulation of unclean utensils near the stall.
9. Water is utilised in various street-vendor operations, such as washing of raw materials, equipment and utensils, as well as fermentation and cooking. One of the primary issues about biological risks in street

meals is the frequent lack of potable water around stalls and the subsequent re-use of the water used to clean utensils and equipment.

Recommendations

While street food selling is becoming more popular as an urban phenomenon, it is critical to identify methods that improve consumer safety. There are several precondition systems: The major reference models are GAPs (Good Agriculture Practices), GHPs (Good Handling Practices), and GMPs (Good Manufacturing Practices). Focus on the challenges mentioned above, the following recommendations for effective and inclusive street food standards are offered.

1. Establish a Separate Street Food Regulatory Body such as Environmental Health and sanitation units (EHU), Food and Agriculture Organization (FAO).
2. Use (Hazard Analysis Critical Control Point) HACCP to Develop Context-Specific Laws.
3. Increase the Involvement of Stakeholders in Inspections and in Research.
4. Improve Communication between Street Food Vendors and Regulators.
5. The vending sites should be in a particular location where vendors may operate: if feasible, the space should be indoors or covered so that foods are not exposed to airborne pollutants.
6. Food merchants shall confirm that raw materials meet the safety requirements established on the official food marketing industry in terms of residues and chemical pollutants.
7. During transport, cover foods with appropriate material to protect them from environmental pollutants
8. Store the food in proper containers to avoid the leaching of toxic substances.
9. Chose the more appropriate cooking method according to the nature of the food matrix.
10. Apply only fumigants and sanitizers approved for use in food facilities.

Conclusion

Consumption of street food cannot be ignored because of the inexpensive, convenient, often nutritious and attractive items for urban as well as rural people. However, its production, serving style and packaging and storage should be in a hygienic manner for consumer protection. Apart from this, Food hygiene regulations and food safety systems should be applied to ensure the good quality of the street food. Over the years, special emphasis has been paid to the obvious microbiological risks in street food, as well as the steps required to limit their occurrence, but the chemical/toxicological concerns have been relatively ignored until today.

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Niger – Traditional Oilseed Crop of High Altitude and Tribal Areas of A.P

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D. Sekhar[1], Sr. Scientist[1], P. Seetharamu[1], Sr. Scientist[1], G. Rama Rao[1]
[1]Regional Agricultural Research Station, Chintapalli, Andhra Pradesh.

Niger (*Guizotia abyssinica* L.) crop is generally considered a minor oilseed crop, it is having 35 to 40% of oil content with 18 to 24% protein in the seed. Niger cake after oil extraction can be used for livestock feed. Niger oil has good keeping quality and has more than 70% unsaturated fatty acids free from toxins. Niger crop is a good source for apiary, and hence maintained as subsidiary unit with niger crop. The crop is capable to produce good yields even under low soil fertility, moisture stress and poor crop management. Niger has an advantage of having less incidence of pests and diseases, and attack of wild animals. Niger has great potential for soil conservation. These attributes favour its cultivation on hilly areas, marginal and sub marginal lands in high altitude and tribal zone of Andhra Pradesh. Niger is primarily grown on the less fertile soils in the tribal areas under low input conditions. Further it is the traditional oilseed crop of tribal community for their livelihood sustainability.

Sowing Time

Optimum time of sowing for niger crop is second fortnight of August to first fortnight of September in high altitude and tribal zone of Andhra Pradesh. Late sowing reduces yields due to possible drought in critical period of flowering and seed setting. Light soils with moisture retention and drainage feasibility are suitable. Two to three ploughings with incorporation of farm yard manure @ 2.5 t/ac in last ploughing are recommended.

Cropping System

Generally, the tribal farmers cultivate the niger crop after harvest of the *kharif* maize/ millets etc and starts growing the crop as late *kharif* or early *rabi* season from August second fortnight to first fortnight of September and harvests in December. To enhance the productivity of niger in tribal areas the integration of apiary at 4-5 bee hives per acre improves the economic status of the tribal farmers.

Seed and Sowing

Generally, 5 kg of seed per hectare is required for the line sown crop. KGN-2, JNS 26, JNS 28 varieties yields 10 quintals per hectare in 100-110 days. Farmers of this region generally sown by broadcasting. However, line sowing at a spacing of 30 cm between the rows and 10 cm plant to plant in the rows is recommended. Seeds are sown mixed with sand/ powdered FYM to ensure even distribution of seed. Seed treatment with carbendazim @ 5 g/kg or *Trichoderma viridae* 10 g/kg of seed before sowing protect the crop from seed and soil borne diseases.

Intercultural Operations

Weeding is done 15-20 days after sowing and may be repeated after 15 days after the first weeding if the weed intensity is high before top dressing of nitrogenous fertilizer. Cuscuta (*Cuscuta hyalina/ C. chinensis*) infestation is major problem in niger crop. Eliminating *cascuta* seed by sieving with 0.85 – 1.0 mm holes sieve or soaking 5 kg seed in 20 litres of salt (3 kg) water is essential. Pre-emergence application of 3.25 litre Pendimethalin/ha is recommended to control *cascuta*. Removal and destroying of *cascuta* at the early stage of crop growth, prior to flowering, is to be done to prevent nutrient loss and further spread of this parasitic weed.

Nutrient Management

Application of FYM 5 t/ha and 20 kg N/ha at the time of sowing**.** Top dressing of 8 kg N/ac as Urea, 15-20 days after sowing will give additional yields to the tune of 80 kg/ac.

Pest Management

Though the pest problem is less for this crop, under favourable conditions pest menace is possible. Removal of egg masses and larvae of defoliators such as *Spodoptera* is an eco-friendly approach. Spraying of 2.5 ml/l of chlorpyriphos for defoliators and dimethoate(2.0ml/l) for sucking pests is recommended. Spraying mancozeb (3.0 ml/l) at 15 days interval controls alternaria leaf blight.

Niger crop generally matures in 100-110 days. The crop should be harvested when the leaves dry up and the capitula turns brownish/blackish in colour. Harvesting to the ground level, drying, threshing by beating with sticks and drying the seed up to 8-9% moisture in the seed is recommended.

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A Study on Physico – Chemical Parameters of Two Different Types of Salt Pans in Tuticorin

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Sivanesh H[1]
[1]Manonmaniam Sundaranar University, Tirunelveli, Tamil Nadu.

Summary

In the present study the ecology, physiology and biochemistry of two salt pans in two different sites were selected. Fir's tone is control ponds and the second one is experiment ponds. Water was taken from the 5 ponds of each site, for the analysis of the different parameters. The physical parameters such as salinity, water density, temperature both water and soil, water depth, pH, rate of evaporation, dissolved oxygen and odour, biomass were measured. The chemical parameters such as NaCl, $CaSO_4$, $MgSO_4$ and $MgCl_2$ calcium were analysed. The biomass was calculated in different two sites. The average biomass was measured in 1400/m^3 at site I. In site 2, the average biomass is 2,40,000/m^3 respectively. The present study gives an idea of the ecology, physiology and biochemistry of the two different saltpants in Thoothukudi. The presence of *Artemia* show that the saltpan although hyper saline to increase the production of salt quality. The physico-chemical parameters studied gives us an idea of the micro environment prevailing in the saltpans.

Introduction

Salt pans are shallow open pans used to evaporate brine for the production of salt. The pans are usually found on the coast, while those used to extract salt, from solution mined brine will be found near to the brine shaft. The salt pan contains numerous micros and macro-organisms which produce energy source from the process of photosynthesis. Some primary producers are imperceptible in the salt pan in the name of algae to produce energy in the form of food for other primary consumers. One of the primary consumers a crucial role taken by the brine shrimp of *Artemia salina*. It is present only in hyper saline water among the micro and macro-organisms. The brine shrimp is found in inland salt water bodies. They also occur in many other bodies of water with any salt content, salt swamps near any coast, and many man-made saltpans around the world.

Description of Brine Shrimp

Artemia is a genus of aquatic crustaceans Known as brine shrimp and artemia is a Zooplankton. Artemia, the only genus in the Family artemiidae. *Artemia sp* populations are found worldwide in inland saltwater lakes,but not in oceans. An adult Artemia salina is usually about 8-10 mm but can reach up to 15 mm depending on its environment. It has an elongated body divided into at least 20 segments and attached to its trunk are approximately 10 sets of flat, leaf-like appendages called phyllopodia that beat in a regular rhythm. The adults can be pale white, pink, green, or transparent and usually live for a few months. They have compound eyes set on stalks and reduced mouthparts. *Artemia salina* is in the order Anostroca, literally meaning "no shell," which classifies the shrimp with other species that have no carapace (a hard, bony outer covering). Its subclass Brachiopoda literally means "gill foot," referring to the fact that the gills are on the outer side of the limb bases. In feed mechanism of artemia seems filter feeding in nature then it takes calcium ions from the salt pan. *Artemia sp* being a non-selective filter feeder filters off excessive calcium in the brine and known to reduce the calcium content in the salt (Koyam et al., 2001). It is clear that artemia possess mechanisms that can actively excrete Nacl and take up water in hypertonic media. It has been demonstrated that artemia can lower the haemolymph osmotic pressure by excreting Nacl from the haemolymph against the concentration gradient. (P.C Croghn 1957).

Review of Literature

Silas Ebenezer et al., 1993 reported that the maximum temperature of the salt lagoon region was 32°C - 35°C. Chakraborti et al., 1985 reported that temperature varied from 25.6°C-29.8°C in the brackish waters. Temperature was significant at 1% level in the brackish water (Sathayajith et al., 1993). Bensam et al., 1975 reported that the temperature of the veppalodai saltpan varied from 24.8°C-3.7°C. the temperature in the upper-middle and bottom water of the Baltic Sea fluctuates very little from the mean (Nebring et al., 1980). The optimum temperature tends to be in the 35°C -55 °C range (Grand and Larsen,1989), which again, is reflective to their environement (Sakthivel,2008). Gopalan Krishnan et al., 1994 reported that dissolved oxygen varied from 3.3-4.0 ppm in Thoothukudi saltpan. During summer the Dissolved Oxygen content ranged between 1 and 2.5 ml /L while during the Northeast monsoon period it changed between 4.0 and 6.0 ml/L. Silas Ebenezer et al., 1993 and Bensam et al., 1975 observed that dissolved oxygen content from 1.8 ml/L-3.4 ml/ L in veppalodai saltpan.The various pans in solar saltpans generally have a ph in the neutral to slightly alkaline range of 7.1 to 8.1 (marichamy et al., 1987).ph values were in the range between 7.90-8.25 in the saltpan. The salinity value ranges from 22.4% - 39.2% in the Veppalodai saltpan. Oren *et al.* (1999), the salinity varies from 60 to 120 ppt in Ribandar, Goa. Nebring *et al.* (1980) reported that an increase in salinity implies that the eutropication is closed connected to the hydrographic process. The highest salt concentration was recovered at 180* in the saltpan (Neiji Toumi *et al.,* 2005). Marichamy *et al.* (1987) reported that the salinity ranges from 38 – 48 ppt in the saltpan. Ammonia concentration showed an increase in the salt lagoon region (Silas Ebenezer *et al.,* 1993). Phosphate in the soil phase was more than 1.32 mg / 100g (Chakraborti *et al.,* 1985). Silas Ebanezer *et al.* (1993) reported that the phosphate concentration showed an increase in the salt lagoons. Patrick Sorgeloos *et al.* (1984) reported that the common temperature optimum was between and 20^0 and 25^0C. Interaction between temperature and salinity was negligible or very limited, substantial differences in tolerance were recorded in particular at the lower end of the range of experimental salinities and at the upper end of the range of temperatures. Crogan (1957) reported that *Artemia* must possess mechanisms that can actively excrete NaCl take up water in hypertonic media. The technique combines physical process and biological manipulation in the process of salt production which is considered as the effective way in northern China.

Materials and Methods

Estimation of Physico – chemical parameters: The physico – chemical parameters are analyzed in college laboratory as per standard procedure. (Ramadhas, V. and Santhanam, R.1996).

Results

The Physico - chemical parameters observed in the two different sites. The salinity varied in different two sites. In site 1 the minimum salinity was 7” Baume was noted at 1st pond and the maximum salinity 28” Baume was noted at 5th pond. In site 2 the minimum salinity was 7” Baume was noted at 1st pond and the maximum salinity 28” Baume was noted at 5th pond. The water density varied in the two different sites. In site 1, the minimum density 70ppt was noted in 1st pond and the maximum density 280ppt was noted in 5th pond. In site 2, the minimum density 70ppt was noted in 1st pond and the maximum density 160ppt was noted in 5th pond. The air temperature varied in the two different sites. In site 1, the minimum air temperature (28·C) in all the 5 ponds and maximum air temperature (31°·C) was noted in all the 5 ponds. In site 2, the minimum air temperature (29°C) in all the 5 ponds and maximum air temperature (32°·C) was noted in all the 5 ponds. In site 1, the minimum water temperature (30°C) in 1st pond and the maximum water temperature (38.5°C) was observed in 5th pond. In site 2, the minimum water temperature (31°C) was noted in 2nd and 5th pond. The maximum water temperature (36°C) was noted in 4th pond. The bottom temperature varied in two different sites. In site 1 the minimum bottom temperature (soil temperature) 29.5°C was noted at 1st pond and maximum bottom temperature 42°C was noted at 5th pond. In site 2, the minimum bottom temperature 30°Cwas noted at 1st pond and the maximum bottom temperature 41°C were noted at 5th pond. The water depth varied in the two different sites. In site 1, the minimum water depth 5cm was noted at 5th pond and the maximum water depth 37.5 cm was noted at 1st pond. In site 2, the minimum water depth 32cm was noted at 5th pond and maximum water depth 86cm was noted at 1st pond. The pH values are measured in varied at two different sites. In site 1, the minimum pH value 1 and 7 was noted at 1st pond and the maximum pH value is 9.2 was observed at 5th pond. In site 2, the minimum pH value 7.5 was noted at 1st pond and the maximum pH value 8.5 was noted at 5th pond. The rate of evaporation (avg in mm) varied in two different sites. In site 1, the minimum rate of evaporation 3.9 mm was noted at 1st pond. Then the maximum evaporation 4.4 mm was noted at 5th pond. In site 2, the minimum rate of evaporation 6.1 mm was noted at 3rd pond and the maximum rate of evaporation 6.9 mm was noted at 5th pond. The dissolved oxygen is important physic-chemical parameters in this project. The dissolved oxygen varied in different sites. In site 1, the minimum amount of dissolved oxygen 0.16 ml O_2/l was noted at 1st pond and the maximum amount of dissolved oxygen 1.3 ml O_2/l was noted at 3rd pond. In site 2, the minimum amount of dissolved oxygen 0. 6 ml O_2/l was noted at 1st pond and the maximum amount of dissolved oxygen 1.6 ml O_2/l was noted at 3rd pond. The population dynamics varied in different two sites. In site 1, the minimum amount of population was measured 280nos/m^3 at 5th pond and the maximum amount of population was measured 76,500nos/m^3 at 1st pond and is shown in (fig 10).in site 2, the minimum amount of population was measured 1, 19,800nos/m^3 at 5th pond and the maximum amount of population was measured 2, 40,000nos/m^3 at 1st pond. The contents of chemicals present in the brine sample. In site 1, brine sample brine density was measured in 22 Baume. The NaCl 18.13, $CaSo_4$ 2.49, $MgSo_4$ 23.52, $MgCl_2$ 55.86 and are shown in table 6.in site 1, the chloride content was 96.62 and site 2, chloride content was 96.63 as shown in table 7. In control ponds the water calcium is measured in 5 ponds. The minimum calcium level in water 0.22 was measured at 5th pond and the maximum calcium level in water 0.38 was measured at 2nd pond. In experimental ponds the water calcium measured in 5 ponds. The minimum calcium level in water 0.12 was measured at 5th pond and the maximum calcium level in water 0.37 was measured at 1st pond. In control ponds the sediment calcium is measured at 5 ponds. The minimum sediment calcium was measured at 5th pond 0.31. The maximum sediment calcium is 0.51 was measured at 1st pond. In experimental ponds the sediment calcium is measured at 5 ponds. The minimum sediment calcium is 0.10 was measured at 5th pond and the maximum sediment calcium is 0.48 was measured at 1st pond. There was significant negative correlation $p<0.005$ between the biomass of Artemia and the concentration of calcium in water in the experimental ponds. On the contrary no such significant observation could be made in the control ponds.

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Aphelandria as House Plant

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M. Mohanalakshmi[1], G. Sathish[2]
[1]Assistant Professor (Horticulture), Tamil Nadu Agricultural University (TNAU).
[2]Regional Research Station (RRS), Vridhachalam, Cuddalore District, Tamil Nadu.

Common name: Zebra plant.
Family: Acanthaceae.
Type: Greenhouse perennial.
Flowering season: early to late autumn (August to October).
Mature size/ shape: 20 cm to 90 cm.
Special use: House plant.

Aphelandra squarrosa


***Aphelandra squarrosa* the aptly named zebra plant is a popular house plant. With a little effort it can be persuaded to produce a dramatic head of golden yellow bracts.**

The name *Aphelandra*, deriving from the Greek apheles, simple, and aner, male, refers to the plant's anthers that are one celled.

The *Aphelandra* came from brazil and was obtained there by the nursery farm of Linden in the 1860's. There are many aphelandras in south America, but none seem to have the manifold attractions of *Aphelandra squarrosa*, although Aphelandra *fascinator*, with its brilliant scarlet flower, could be usefully re introduced. *Squarrosa* is from the Latin for curved, referring to the leaves.

Aphelandra squarrosa makes a rather stocky plant, with slightly leathery, elliptical leaves that may be as long as 25 cm and half as wide. They are of dark shining green colour and the main veins are picked out conspicuously in ivory.

A few named varieties are now available, of which Brockfeld has exceptionally large leaves, but it practically never flowers. To compensate for this, the leaves contain far more ivory than the originally imported stock, and so the foliage is more striking. Before Brockfeld came silver beauty, with leaves containing as much ivory as green, but this is hard to obtain. Dania, a rather dwarf form rarely over 20 cm high, has smaller leaves that are held horizontally, not drooping as it usually the case; it is quite free flowering.

Once the plant has become pot bound it produces a four –sided pyramidal head of yellow bracts, from which the long, two lipped, yellow tubular flowers emerge over a two-to-three-week period. Since the bracts hold their colour from the time when they are first seen until about a week after the last flower has faded, the floral display is maintained for a long time. Eventually the bracts turn green and then the whole flower head should be removed. Once this has been done, side shoots will start to appear at the leaf axils and these can be taken off when sufficiently firm, and rooted as cuttings. For this, however, a temperature of 21^{o}c is wanted, so it is not easy without a green house.

The *Aphelandra* is greedy and requires a rich soil mixture, but it should not be fed until the flower buds have been formed. If fed, it will be encouraged to produce more and larger leaves, so if the plant is being grown only for the sake of its foliage, you can go on feeding. Should your objective be blosoom, however, you have to let the plant become pot- bound and withhold any feeding until you see that it is going to bloom. Even with these precautions it is not easy to persuade the plant to flower well in the home, as the amount of light available is often insufficient, unless you have a sunny room. If you have a green house there should be no difficulty at all.

The *Aphelandra* needs a humid atmosphere, so if it is kept in the house, plunge the pot into a large container with the gap between the two filled with some absorbent material that is always kept moist.

It requires fresh soil every year, but is not potted on into a larger pot. Instead, you remove the soil ball from the pot and wash off the existing soil, leaving the root intact. You then put fresh soil into the same pot and replace the *Aphelandra*; this should be done in late spring (April) or early summer (May), when the days are reasonably long. But the plant needs extra warmth for about ten days after this operation, so you may prefer to complete it before turning off your central heating.

Give the *Aphelandra* water all times, although less is required in winter when this native of the Brazilian jungle should be kept warm; 15^{o}c is best, but 13^{o}c is adequate. The *Aphelandra* grows slowly under 15^{o}c but speeds up as the temperature rises.

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Homemade Pesticides for Healthy Growing of Kitchen Garden

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Tekkam Shirisha[1], Dr. V. R. Joshi[1]
[1]Mahatma Phule Krishi Vidyapeeth, Rahuri, 413722, Maharastra, India.

Introduction

People increasingly prefer to grow their vegetables and fruits using organic methods, or to create their kitchen gardens, to live a healthy lifestyle. Pesticides are damaging to humans and animals as well as the environment. Heavy exposure to these substances produces a variety of ailments and health effects, ranging from respiratory to cardiovascular issues. If you want to grow chemical-free veggies and fruits, you should know that certain natural wonders in your kitchen can be used as natural insecticides to keep insects and pests at bay.

Why do we Use Natural Pesticides?

It's better for the environment; becoming organic reduces pollution and eliminates the introduction of new chemicals into your soil, plants, and, eventually, your food. For many gardeners, one of the most important benefits is improved health.

Importance of Natural Pesticides

1. They are non-toxic.
2. These natural pesticides are great at ridding your crops of hazardous pests.
3. These are safe enough to avoid poisoning you and your family.

List of Natural Pesticides

1. Neem
2. Salt
3. Onion and garlic solution
4. Eucalyptus oil solution
5. Chrysanthemum tea solution
6. Vegetable oil spray
7. Chilli and pepper solution
8. Eggshell powder
9. Vinegar
10. Garlic and mint spray
11. Tomato brew
12. Basil tea

13. Citrus spritz.

Neem

For a long time, neem has been utilized for medicinal purposes, and it's also been known to be utilized as a pest deterrent. This medicinal herb's bitter taste and pungent odor may keep bugs away from your plants. It is non-toxic to both humans and the environment. Add some neem oil, a little liquid soap, and some warm water to a spray bottle. When neem oil is sprayed at the age of 22 days, the outcomes are better.

Salt

Salt spray for pest control is one of the best, cheapest, and most natural ways to prepare pesticides at home. It will also aid in the absorption of magnesium, phosphorus, and sulphur, which will improve nutrition. To make the solution, dissolve the salt in the water and thoroughly mix it in the spray bottle. sprinkling on plants.



Onion and Garlic Spray

We may make a highly intense spray by pureeing two full bulbs of garlic and onion in only 12 cups of water. Put the garlic and onion in a bowl and crush them. Fill it halfway with boiling water, cover it, and leave it to steep overnight. Before putting it in a spray bottle, strain it to remove any garlic or onion pieces that can block the nozzle.

Eucalyptus Oil

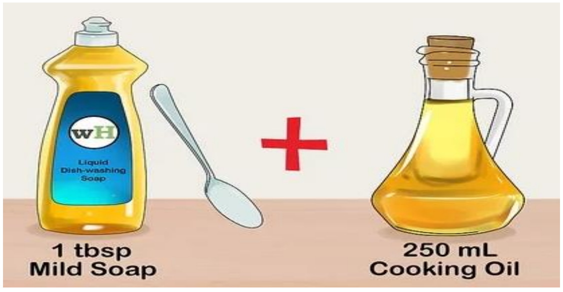
Eucalyptus oil has a strong odor that works to prevent insects and pests. Spray some oil on your plants to keep pests away.


Chrysanthemum Flower Tea

Pyrethrum is a chemical substance found in chrysanthemum blooms. This chemical is thought to harm insects' and pests' neurological systems. For around 20 minutes, boil some dried flowers in a pan of water. Strain, chill and spray as needed. This solution can be stored for up to two months.


Vegetable Oil Spray

When vegetable oil is mixed with a bar of mild soap and sprayed on plants, it kills aphids, mites, thrips, and other pests. Because the oil coats the insects' bodies, it effectively suffocates them by blocking the pores through which they breathe.



Chilli or Pepper Spray

Chilli or pepper spray is a fantastic natural insecticide that can be created at home and used to treat a variety of pests. Fresh spicy chillies can be used to make chilli spray. To produce chilli spray, mix half a cup of fresh chilli peppers with one cup of water until a fine paste is formed. Bring one quart of water to a boil once more. Allow cooling before straining and using for other purposes.


Vinegar

One of the greatest ingredients for making a pest control spray is vinegar. The vinegar's acidity is strong enough to kill a variety of pests. Vinegar is frequently used as a contact pesticide, meaning it must be sprayed directly on the spotted bug to be effective.

Eggshell

Eggshells can be used to keep pests at bay. Using a grinder or blender, crush eggshells into a fine powder. Sprinkle eggshell powder over plant leaves to use as an organic insect control.


Garlic and Mint Spray

Garlic cloves, mint leaves, and cayenne pepper combined will keep bugs out of from garden and aid to restore damage to plants that have already been harmed by insects.



Tomato Brew

Soak tomato plant leaves in water for a few days after crushing them. Strain. Controls grasshoppers and whiteflies.

Basil Tea

After bringing 4 cups of water to a boil, add the basil. Remove the pan from the heat, cover, and set aside to cool followed by strain and soap mix. It's used to control Aphids in plants.


Citrus Spritz

Bring 4 cups water to a boil, then remove from the heat and stir in the citrus peels. Cover and set aside to cool. Strain. Whiteflies are easily repelled with this product.

Conclusion

Natural pesticides are an environmentally friendly alternative to chemical pesticides. These are derived from our kitchen and are used to protect crops from various pests. Natural pesticides not only give chemical-free food but also aid in the reduction of pollution in the environment. Natural pesticides, unlike artificial pesticides, have no long-term effect on food crops.

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Polymerase Chain Reaction

Article ID: 35047

Loudiya Krishna Nayak[1], Arghya Mani[1]
[1]School of Agriculture, Lovely Professional University, Phagwara, Punjab.

The polymerase chain reaction technique is carried out in vitro and is used for the amplification of DNA. It was developed by Kary Mullis in 1983. Through this technique a billion copies of the desired DNA or RNA can be made in a matter of few hours.

The PCR reaction mix contains genomic DNA having the target sequence, two oligonucleotide primers- forward and reverse primer that are complementary to the borders of the two strands of the desired DNA segment, the four deoxy nucleoside triphosphates i.e., dTTP (deoxythymidine triphosphate), dCTP (deoxycytidine triphosphate), dATP (deoxyadenosine triphosphate) and dGTP (deoxyguanosine triphosphate) and Taq polymerase, MgCl2 and Buffer.

Designing of Primer Good primer design is essential for successful reactions. The important design considerations described below are a key to specific amplification with high yield.

The preferred values indicated are built into all our products by default.
1. Primers should be 17-28 bases in length.

2. The base composition should be 50-60% (G+C).

3. Primers should end (3′) in a G or C, or CG or GC: this prevents "breathing" of ends and increases the efficiency of priming.

4. Temperature between 55-80^{o}C is referred. The basic formula to calculate melting temperature is Tm = 4°C X (number of G's and Cs in the primer) + 2°C X (number of As and Ts in the primer). Two primers must have a similar Tm value. In case of several primer candidates, we have to choose primers which have the higher Tm value among them.

5. There should be no base complementarities between the two primers. 3′-ends of primers should not be complementary (i.e., base pair), as otherwise primer dimers will be synthesized preferentially to any other product;

6. Primer self-complementarity (ability to form secondary structures such as hairpins) should be avoided.

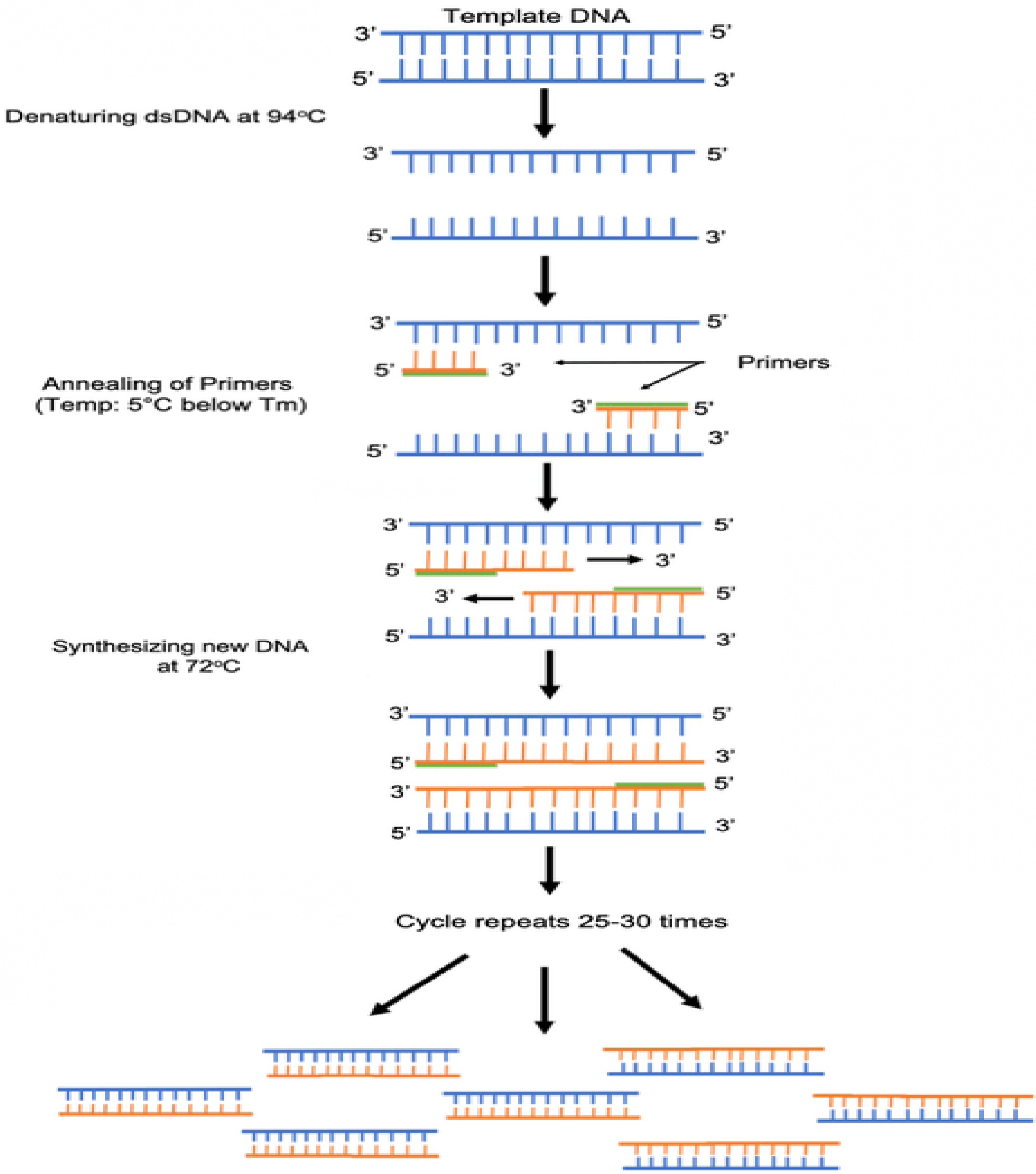
Runs of three or more Cs or Gs at the 3′-ends of primers may promote mis priming at G or C-rich sequences (because of stability of annealing) and should be avoided.

Procedure of PCR

Denaturation: During denaturation step, the reaction mixture is first heated to a temperature between 90-98^{o}C that ensures DNA denaturation. The duration of this step in the first cycle of PCR is usually 2 min at 94^{o}C.

Annealing: During annealing, the mixture is cooled to a temperature of 40-60^{o}C so that annealing of primer to the complementary sequences in the DNA takes place. The duration of annealing step is usually 1 minute. The primer-template hybrid formation is greatly favoured over reannealing of the template strand.

Primer: Extension By utilizing 3'-OH of the primers, primer extension is done. The duration of primer extension is usually 2 minutes at 72^{o}C. The primers are extended towards each other so that the DNA segment lying between the two primers is copied. Taq polymerase catalyses the extension of DNA segment. The optimum temperature for working of Taq polymerase is 72-74oC. These cycles are repeated 20-30 times to get a million copies of desired gene segment as after each cycle there is (2n) exponential increase in the copies of DNA segment.



Steps in PCR reaction

Applications of PCR

Infectious disease diagnosis, progression, and response to therapy: PCR technology facilitate the detection of DNA or RNA of pathogenic organisms and as such, helps in clinical diagnostic tests for a range of infectious agents like viruses, bacteria, protozoa etc. These PCR-based tests have numerous advantages over conventional antibody-based diagnostic methods that determine the body's immune response to a pathogen. In particular, PCR-based tests are competent to detect the presence of pathogenic agent in-advance than serologically-based methods, as patients can take weeks to develop antibodies against a contagious agent. PCR-based tests have been developed to enumerate the amount of virus in a person's blood (viral load') thereby allowing physicians to check their patient's disease progression and response to therapy. This has incredible potential for improving the clinical management of diseases caused by viral infection, including AIDS and hepatitis, assessment of viral load throughout and after therapy. PCR technique is also used to for checking the mycoplasma contamination in mammalian cell lines.

Diagnosis of genetic diseases: The use of PCR in diagnosing genetic diseases, whether due to innate genetic changes or as a result of natural genetic mutations, is becoming more common. Abnormality can be diagnosed even prior to birth. Single-strand conformation polymorphism (SSCP), or single-strand chain polymorphism, is defined as the conformational difference of single-stranded nucleotide sequences of identical length as induced by differences in the sequences under certain experimental conditions. These days, SSCP is most applicable as a diagnostic tool in molecular biology. It can be used in genotyping to detect homozygous individuals of different allelic states, as well as heterozygous individuals who inherit genetic aberrations.

Genetic counselling: It is done for the parents to check the account of genetic disease beforehand to make a decision on having children. This is of course governed by national laws and guidelines. Detection of genetic disease before implantation of an embryo in IVF (In vitro fertilization) also known as pre-implantation diagnosis can also be done exploiting PCR based method. Further to diagnose inherited or a spontaneous disease, either symptomatic or asymptomatic (because of family history like Duchene muscular dystrophy) PCR based method is very useful.

Forensic sciences: DNA fingerprint is one of the most exploited applications of PCR (also known as DNA profiling). Profiles of specific stretches of DNA are used in genetic fingerprinting (generally 13 loci are compared) which differs from person to person. PCR also plays a role in the analysis of genomic or mitochondrial DNA, in which investigators used samples from hair shafts and bones when other samples are not accessible.

Research in Molecular Biology: PCR is an essential technique in cloning procedure which allows generation of large amounts of pure DNA from a tiny amount of template strand and further study of a particular gene. Some alterations to the PCR protocol can generate mutations (general or site-directed) in a sequence either by an inserted fragment or base alteration. PCR is used for sequence-tagged sites (STS 's) as an indicator that a particular segment of a genome is present in a particular clone. A common application of Real-time PCR is the study of expression patterns of genes during different developmental stages. PCR can also investigate _ON or OFF 'of particular genes at different stages in tissue (or even in individual cells).

Others: PCR has numerous applications in various fields. The Human Genome Project (HGP) for determining the sequence of the 3 billion base pairs in the human genome, relied heavily on PCR. The genes associated with a variety of diseases have been identified using PCR. For example, Duchenne muscular dystrophy, which is caused by the mutation of a gene, identified by a PCR technique called Multiplex PCR. PCR can help to study for DNA from various organisms such as viruses or bacteria. PCR has been used to identify and to explore relationships among species in the field of evolutionary biology. In anthropology, it is also used to understand the ancient human migration patterns. In archaeology, it has been used to spot the ancient human race. PCR commonly used by Palaeontologists to amplify DNA from extinct species or cryopreserved fossils of millions of years and thus can be further studied to elucidate on.

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Southern Blotting Technique

Article ID: 35048

Loudiya Krishna Nayak[1], Arghya Mani[1]
[1]School of Agriculture, Lovely Professional University, Phagwara, Punjab.

Southern Blot

Southern blots are used to determine the identity, size, and abundance of specific DNA sequences. The southern blot protocol begins with DNA extraction from the cells or tissues, which is then enzymatically digested to produce DNA fragments. The fragments are separated by size on an agarose or polyacrylamide gel via electrophoresis. Smaller fragments will migrate farther on the gel than larger ones. Following electrophoresis, the DNA on the gel is transferred to a nylon membrane. The membrane is incubated with a nucleic acid probe that has a sequence homologous to the target sequence and is labelled with radioactivity, fluorescent dye, or an enzyme capable of generating a chemiluminescent signal. Hybridization of complementary sequences occurs during incubation, and the unhybridized probe is removed by washing with buffer. The fully hybridized labelled probe molecules will remain bound to the blot. Detection methods differ based on the probe label; radiolabelled probes are visualized with X-ray film or phosphor imaging, and enzymatically labelled probes are visualized with chemiluminescent substrate.

Southern Blot Protocol

1. DNA isolation.

2. Restriction digestion: Digest the DNA with a restriction enzyme, and if necessary, concentrate digested DNA.

3. Gel electrophoresis: Prepare an agarose gel and either TAE or TBE buffer (buffer selection will depend on the duration of the run and the size of the DNA fragments). Load samples into wells and include a DNA molecular weight marker. Run the gel.

4. Transfer:

a. Place the gel in a container with denaturing solution, and wash twice for 15 minutes on a shaker.
b. Rinse with water, then wash with neutralization solution.
c. During the previous step, begin to prepare Whatman paper and nylon membrane for the transfer.
d. Assemble the transfer apparatus with the membrane, Whatman paper, and gel and transfer in SSC or SSPE buffer.
e. When transfer is complete, cross-link DNA in a cross-linker, then rinse the membrane.

5. Pre-hybridization (blocking): Blocking reduces non-specific binding to the membrane. Prepare the pre-hybridization solution and add sample DNA. Remove the blot from the cross-linker, add the pre-hybridization solution and incubate.

6. Hybridization:

a. Prepare the probe mixture (a complementary DNA strand) and buffer.
b. Remove the pre-hybridization solution and incubate the blot with the probe (incubation times will vary depending on the application).
c. Following incubation, perform a low-stringency wash followed by a high-stringency wash to refine the DNA.

7. Probe detection:

a. Rinse the membrane, transfer to a container with blocking solution and incubate.
b. Discard blocking solution, replace with antibody solution and incubate.
c. Discard antibody solution, wash the membrane.

8. Follow manufacturer directions for chemiluminescent detection.

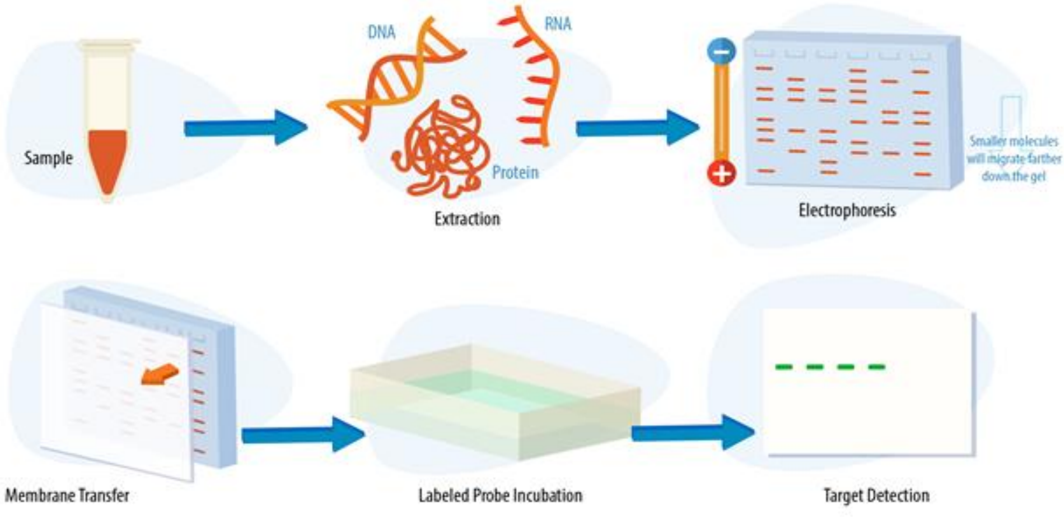


Figure 1: Gel electrophoresis, transfer, incubation, and detection.

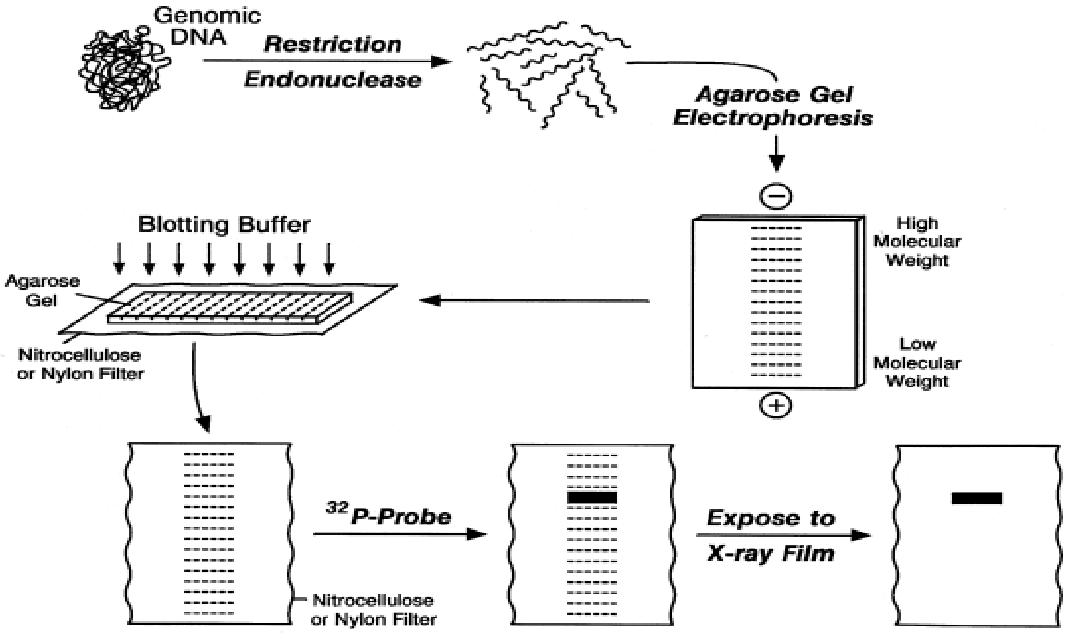
Principle

1. Southern blotting is an example of RFLP (restriction fragment length polymorphism). It was developed by Edward M. Southern (1975). Southern blotting is a hybridization technique for identification of particular size of **DNA** from the mixture of other similar molecules**.** This technique is based on the principle of separation of DNA fragments by gel electrophoresis and identified by labelled probe hybridization.

2. Basically, the DNA fragments are separated on the basis of size and charge during electrophoresis. Separated DNA fragments after transferring on nylon membrane, the desired DNA is detected using specific DNA probe that is complementary to the desired DNA.

3. A hybridization probe is a short (100-500bp), single stranded DNA. The probes are labelled with a marker so that they can be detected after hybridization.

Procedure/ Steps



1. Restriction digest: by RE enzyme and amplification by PCR.
2. Gel electrophoresis: SDS gel electrophoresis.
3. Denaturation: Treating with HCl and NaOH.
4. Blotting.
5. Baking and blocking with casein in BSA.

6. Hybridization using labelled probes.
7. Visualization by autoradiogram.

Step I: Restriction Digest

1. The DNA is fragmentized by using suitable restriction enzyme. RE cuts the DNA at specific site generating fragments.
2. The number of fragments of DNA obtained by restriction digest is amplified by PCR.

Step II: Gel Electrophoresis

The desired DNA fragments is separated by gel electrophoresis.

Step III: Denaturation

1. The SDS gel after electrophoresis is then soaked in alkali (NaOH) or acid (HCl) to denature the double stranded DNA fragments.
2. DNA strands get separated.

Step IV: Blotting

The separated strands of DNA are then transferred to positively charged membrane nylon membrane (Nitrocellulose paper) by the process of blotting.

Step V: Baking and Blocking

1. After the DNA of interest bound on the membrane, it is baked on autoclave to fix in the membrane.
2. The membrane is then treated with casein or Bovine serum albumin (BSA) which saturates all the binding site of membrane.

Step VI: Hybridization with Labelled Probes

1. The DNA bound to membrane is then treated with labelled probe.
2. The labelled probe contains the complementary sequences to the gene of interest.
3. The probe bind with complementary DNA on the membrane since all other non-specific binding site on the membrane has been blocked by BSA or casein.

Step VII: Visualization by Autoradiogram

The membrane bound DNA labelled with probe can be visualized under autoradiogram which give pattern of bands.

Application of Southern Blotting

1. Southern blotting technique is used to detect DNA in given sample.
2. DNA finger printing is an example of southern blotting.
3. Used for paternity testing, criminal identification, victim identification.
4. To isolate and identify desire gene of interest.
5. Used in restriction fragment length polymorphism.
6. To identify mutation or gene rearrangement in the sequence of DNA.
7. Used in diagnosis of disease caused by genetic defects.
8. Used to identify infectious agents.

Western Blot Technique

Article ID: 35049

Loudiya Krishna Nayak[1], Arghya Mani[1]
[1]School of Agriculture, Lovely Professional University, Phagwara, Punjab.

Western Blot

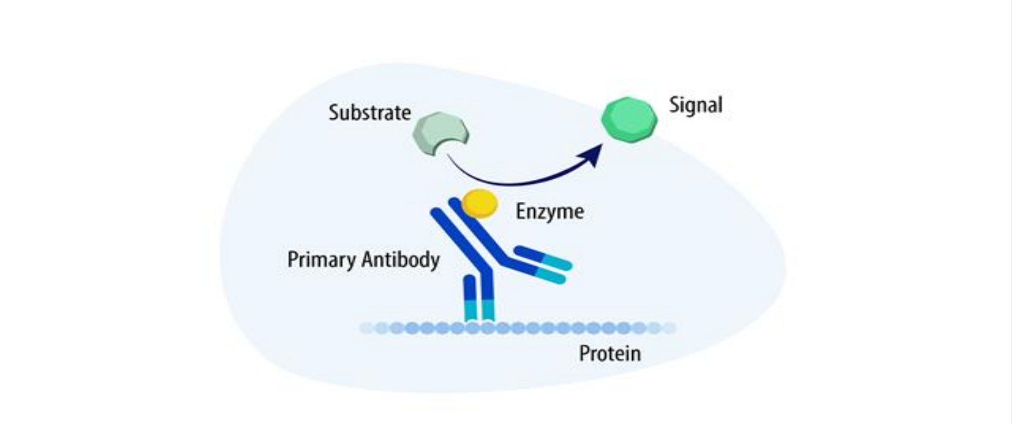


Figure 2: Direct detection relies on a labeled primary antibody.

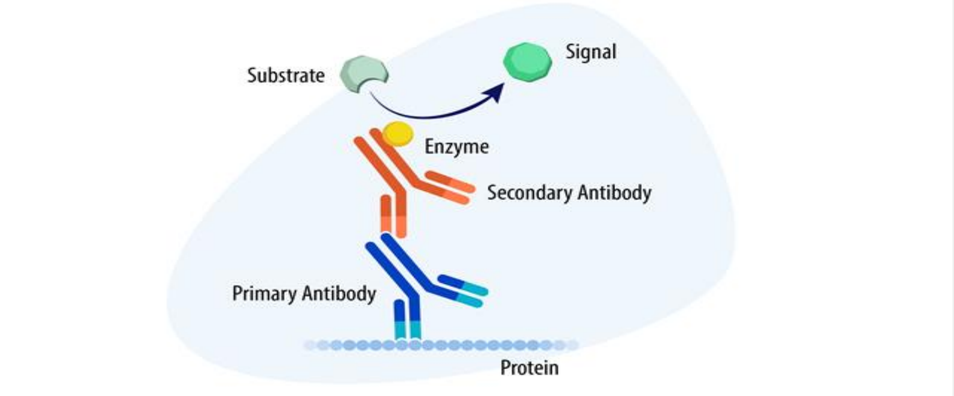


Figure 3: Indirect detection relies on a primary antibody and a labeled secondary antibody.

Western blots are used to determine the identity, size, and abundance of specific proteins within a sample. The western blot protocol begins with sample lysate preparation from tissue or cell culture and separation on a polyacrylamide gel via electrophoresis. The separated proteins are then transferred to a nitrocellulose or polyvinylidene difluoride (PVDF) membrane. The membrane is incubated with a blocking agent to prevent nonspecific binding, followed by incubation with a primary antibody to bind the protein of interest. There are two detection methods, direct and indirect. Direct detection relies on a labelled primary antibody, whereas indirect detection requires a primary antibody directed against the target protein, and a secondary antibody directed against the immunoglobin class or subclass of the primary antibody's species. Visualization methods include colorimetric assays in which a colored precipitate is produced, chemiluminescence, and fluorescence.

Western Blot Protocol

1. Prepare lysate from cell culture or tissue.

2. Sample preparation:

a. Determine the protein concentration of each sample with a protein quantification assay (i.e., Bradford assay).
b. Add an equal volume of 2X Laemmle sample buffer to each sample.
c. Some samples may need to be reduced or denatured, this is achieved by boiling samples in buffer.

3. Electrophoresis:

a. Prepare an SDS-PAGE gel, load samples along with molecular weight marker.

b. Run the gel in running buffer.

4. Transfer:

a. Following electrophoresis, assemble the transfer unit including the gel, PVDF or nitrocellulose membrane, and filter paper.

b. Transfer the proteins to the membrane with transfer buffer.

5. Antibody Staining (indirect detection):

a. Prepare blocking buffer and incubate the membrane to reduce non-specific binding.

b. Incubate the membrane with primary antibody diluted in blocking buffer.

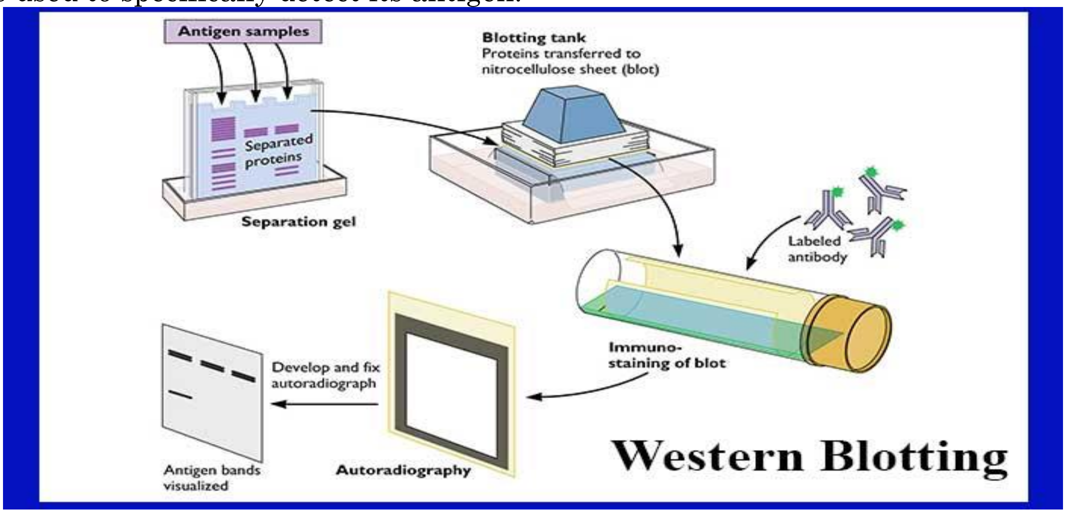
c. Wash the membrane in TBST, and incubate with conjugated secondary antibody diluted in blocking buffer.

d. Wash the membrane in TBST.

e. Follow manufacturer directions for chemiluminescent detection.

Introduction

Western blot is the analytical technique used in molecular biology, immunogenetics, and other molecular biology to detect specific proteins in a sample of tissue homogenate or extract. Western blotting is called so as the procedure is similar to Southern blotting. While Southern blotting is done to detect DNA, Western blotting is done for the detection of proteins. Western blotting is also called protein immunoblotting because an antibody is used to specifically detect its antigen.



Principles of Western Blot Technique

The technique consists of three major processes:

1. Separation of proteins by size (Electrophoresis).
2. Transfer to a solid support (Blotting)
3. Marking target protein using a proper primary and secondary antibody to visualize (Detection).

Electrophoresis used to separate proteins according to their electrophoretic mobility which depends on the charge, size of protein molecule, and structure of the proteins. Proteins are moved from within the gel onto a membrane made of Nitrocellulose (NC) or Polyvinylidene difluoride (PVDF). Without pre-activation, proteins combine with nitrocellulose membrane based on hydrophobic interaction (**Blotting**). For detection of the proteins, primary antibody and enzyme-conjugated secondary antibody are used. In addition of substrate, a substrate reacts with the enzyme that is bound to the secondary antibody to generate coloured substance, namely, visible protein bands.

In this technique, a mixture of proteins is separated based on molecular weight, and thus by type, through gel electrophoresis. These results are then transferred to a membrane producing a band for each protein. The membrane is then incubated with labels antibodies specific to the protein of interest. The unbound antibody is washed off leaving only the bound antibody to the protein of interest. The bound antibodies are then detected by developing the film. As the antibodies only bind to the protein of interest, only one band should be visible. The thickness of the band corresponds to the amount of protein present; thus, doing a standard can indicate the amount of protein present.

Western blotting is usually done on a tissue homogenate or extract. It utilizes **SDS-PAGE (Sodium dodecyl sulfate polyacrylamide gel electrophoresis)**, a type of gel electrophoresis to first separate various proteins in a mixture on the basis of their shape and size. The protein bands thus obtained are transferred onto a **nitrocellulose or nylon membrane** where they are "probed" with antibodies specific to the protein to be detected. The antigen-antibody complexes that form on the band containing the protein recognized by the antibody can be visualized in a variety of ways.

If the protein of interest is bound by a radioactive antibody, its position on the blot can be determined by exposing the membrane to a sheet of X-ray film, a procedure called **autoradiography**. However, the most generally used detection procedures employ enzyme-linked antibodies against the protein. After binding of the enzyme–antibody conjugate, the addition of a chromogenic substrate that produces a highly coloured and insoluble product causes the appearance of a coloured band at the site of the target antigen. The site of the protein of interest can be determined with a much higher sensitivity if a chemiluminescent compound along with suitable enhancing agents is used to produce light at the antigen site.

Applications of Western Blot Technique

1. Identification of a specific protein in a complex mixture of proteins. In this method, known antigens of well-defined molecular weight are separated by SDS-PAGE and blotted onto nitrocellulose. The separated bands of known antigens are then probed with the sample suspected of containing antibodies specific to one or more of these antigens. The reaction of an antibody with a band is detected by using either a radiolabelled or enzyme-linked secondary antibody that is specific for the species of the antibodies in the test sample.
2. Estimation of the size of the protein as well as the amount of protein present in the mixture.
3. It is most widely used as a confirmatory test for the diagnosis of HIV, where this procedure is used to determine whether the patient has antibodies that react with one or more viral proteins or not.

Demonstration of specific antibodies in the serum for diagnosis of neurocysticercosis and tubercular meningitis.

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Northern Blot Technique

Article ID: 35050

Loudiya Krishna Nayak[1], Arghya Mani[1]
[1]School of Agriculture, Lovely Professional University, Phagwara, Punjab.

Northern Blot

Northern blots are used to determine the identity, size, and abundance of specific RNA sequences. Northern blot protocols begin with RNA isolation, and separation techniques vary depending on RNA size. Large RNAs are separated by electrophoresis on a formaldehyde agarose gel or glyoxal agarose gel, which prevents normal base paring and maintains RNA in a denatured state. Small RNAs are separated on a denaturing (urea) polyacrylamide gel. The RNA is then transferred from the gel to a nylon membrane which is then incubated with a radioactively or non-isotopically labelled RNA, DNA, or oligodeoxynucleotide probe. The unhybridized probe is removed by washing with buffer. Radiolabelled probes are visualized with X-ray film, and enzymatically labelled probes are visualized with chemiluminescence.

Northern Blot Protocol

1. RNA isolation

2. Electrophoresis:

- **a. For a formaldehyde agarose gel:** prepare the gel and insert the gel tray into the apparatus. Fill with MOPS buffer, load the samples and include a molecular weight marker. Run the gel, then trim the gel prior to blotting.
- **b. For a glyoxal agarose gel:** prepare the gel and insert the gel tray into the apparatus. Fill with MOPS buffer, prepare samples and load into wells along with RNA ladder.
- **c. For a denaturing polyacrylamide gel**: cast the gel, and mount it in the electrophoresis unit. Prepare samples, load into the gel, and run with TBE running buffer.

3. Transfer:

- **a. For a formaldehyde agarose gel or glyoxal agarose gel**: wash the gel in SSC, then assemble the transfer unit with the gel, filter paper, and nylon membrane. When transfer is complete, place the membrane in a UV cross-linker.
- **b. For a denaturing polyacrylamide gel:** assemble the transfer unit including gel, filter paper, and nylon membrane ensuring they are flooded with TBE. When transfer is complete, place the membrane in a UV cross-linker to fix the RNA to the membrane.

4. Pre-hybridization (blocking): Pre-hybridize the membrane in hybridization solution.

5. Hybridization:

- a. Add probe to the hybridization solution and incubate.
- b. Wash the membrane in low-stringency washes to remove hybridization solution and unhybridized probe, and high-stringency washes to remove partially hybridized molecules.
- c. Follow manufacturer directions for chemiluminescent detection.

Principle

1. The principle of the northern blot is the same as all other blotting technique that is based on the transfer of biomolecules from one membrane to another.

2. The RNA samples are separated on gels according to their size by gel electrophoresis. Since RNAs are single-stranded, these can form secondary structures by intermolecular base pairing. The electrophoretic separation of the RNA segments is thus performed under denaturing conditions.

3. The separated RNA fragments are then transferred to a nylon membrane. Nitrocellulose membrane is not used as RNA doesn't bind effectively to the membrane.

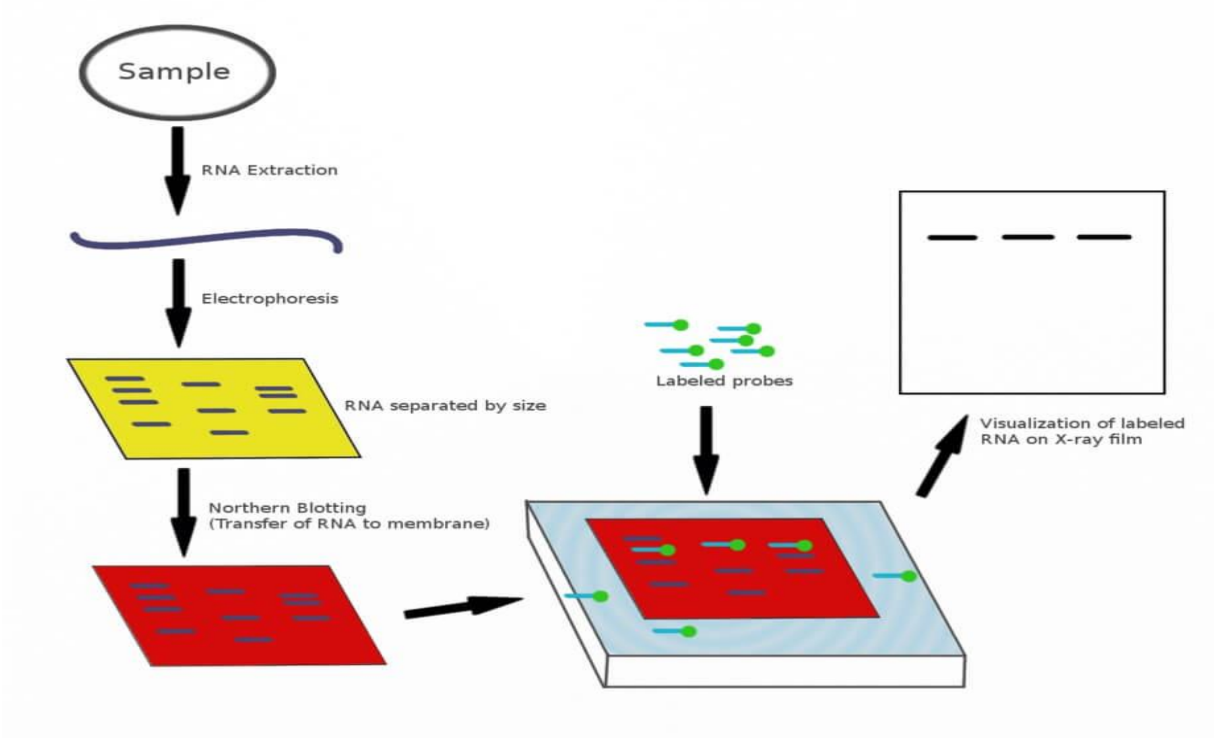
4. The transferred segments are immobilized onto the membrane by fixing agents. The RNA fragments on the membrane are detected by the addition of a labelled probe complementary to the RNA sequences present on the membrane.

5. The hybridization forms the basis of the detection of RNA as the specificity of hybridization between the probe, and the RNA allows the accurate identification of the segments.
Northern blot utilizes size-dependent separation of RNA segments and thus can be used to determine the sizes of the transcripts.

Procedure

1. Separation of RNA on a denaturing gel:

a. The RNA gel solution is prepared by adding formaldehyde to the agarose solution.
b. The cast is assembled, and the prepared denaturing gel is poured into the cast. As the gel begins to set, a comb with appropriate teeth is added to form wells.
c. Once the gel is set, the comb is removed, and the gel is equilibrated with a running buffer for 30 minutes before running.
d. 15 µg RNA sample is mixed with an equal volume of RNA loading buffer. Three µg of RNA markers are added in the same volume of RNA loading buffer.
e. The samples are incubated at 65°C on a heating block for about 12-15 minutes.
f. The samples are loaded to the equilibrated gel, and the first row of wells is filled with RNA markers.
g. The gel is then run at 125V for about 3 hours.



2. Transfer of RNA from gel to the nylon membrane:

a. A nylon membrane is cut that is larger than the size of the denaturing gel, and a filter paper with the same size as the nylon membrane is also prepared.
b. Once the electrophoresis process is complete, the RNA gel is removed from the tank and rinsed with water.
c. An oblong sponge that is slightly larger than the gel is placed on a glass dish, and the dish is filled with SSC to a point so as to leave the soaked sponge about half-submerged in the buffer.
d. A few pieces of Whatman 3mm papers are placed on top of the sponge and are wetted with SSC buffer.
e. The gel is then placed on top of the filter paper and squeezed out to remove air bubbles by rolling a glass pipette over the surface.

f. The nylon membrane prepared is wetted with distilled water on an RNase-free dish for about 5 minutes.

g. The wetted membrane is placed on the surface of the gel while avoiding any air bubbles formation.

h. The surface is further flooded with SSC, and a few more filter papers are placed on top of the membrane.

i. A glass plate is placed on top of the structure in order to hold everything in place. The structure is left overnight to obtain an effective transfer.

3. Immobilization:

a. Once the transfer is complete, the gel is removed and rinsed with SSC, and allowed to dry.

b. The membrane is placed between two pieces of filter paper and baked in a vacuum oven at 80°C for 2 hours.

c. In some cases, the membrane can be wrapped in a UV transparent plastic wrap and irradiates for an appropriate time on a UV transilluminator.

4. Hybridization

a. The DNA or RNA probes to be used are to be labelled to a specific activity of >108 dpm/µg, and unincorporated nucleotides are to be removed.

b. The membrane carrying the immobilized RNA is wetted with SSC.

c. The membrane is placed in a hybridization tube with the RNA-side-up, and 1 ml of formaldehyde solution is added.

d. The tube is placed in the hybridization oven and incubated at 42°C for 3 hours.

e. If the probe used is double-stranded, it is denatured by heating in a water bath or incubator for 10 minutes at 100°C.

f. The desired volume of the probe is pipette into the hybridization tube and further incubated at 42°C.

g. The solution is poured off, and the membrane is washed with a wash solution. The membrane is then observed under autoradiography.

Applications of Northern Blot Technique

1. The technique can be used for the identification and separation of RNA fragments collected from different biological sources.
2. Northern blotting is used as a sensitive test for the detection of transcription of DNA fragments that are to be used as a probe in Southern Blotting.
3. It also allows the detection and quantification of specific mRNAs from different tissues and different living organisms.
4. Northern blotting is used as a tool for gene expression studies related to overexpression of cancer-causing genes, and gene expression during transplant rejects.
5. Northern blotting has been used as a molecular tool for the diagnosis of diseases like Crohn's disease.
6. The process is used as a method for the detection of viral microRNAs that play important roles in viral infection.

Limitations

1. Northern blotting has a lower sensitivity as compared to other modern techniques like RT-PCR and nuclease protection assays.
2. The method requires a large amount of sample RNA, and these should be of high quality.
3. The technique is time-consuming and complex, especially in cases where multiple probes are to be added.

Vitamin-C as a Versatile Vitamin & Role of Vitamin-C in Iron Absorption

Article ID: 35051

D. Sravanthi[1], T. Supraja[1]
[1]Department of Food and Nutrition, Post Graduate and Research Centre, PJTS Agricultural University, Rajendranagar, Hyderabad -500 030, India.

History of Vitamin-C

1. 1700-1800s: A physician discovered sucking juice from lime was protective to prevent scurvy
2. 1928: Vitamin-C also called ascorbic acid or ascorbate was isolated in 1928
3. 1933: Structure of Vitamin-C is determined
4. 1928-1932: Szent-Gyorgyi (1928) and Haworth King (1932) are considered as co-discoverers of vitamin-C.
5. 1937: Szent-Gyorgyi, who isolated the vitamin, and Harworth, who determined structure were awarded noble prize for their vitamin-C work.

Introduction

Vitamin-C exists as both a D- and L-isomer; however, it is the L-isomer of the vitamin that is biologically active in humans. The human being is one of the few mammals unable to synthesize vitamin-C, a six-carbon compound derived from glucose. Animals unable to synthesize vitamin-C include primates, fruit bats, guinea pigs and some birds. The inability to make vitamin-C results from the lack of gluconolactone oxidase, the last enzyme in the vitamin-C synthetic pathway. Food sources of vitamin-C include primarily fruits and vegetables.

Sources

Excellent sources of the nutrient are asparagus, papaya, oranges, orange juice, cantaloupe, cauliflower, broccoli, brussels sprouts, green peppers, grape friut, kale, lemons, and starwberries. Vitamin-C is desroyed by heat, light, oxidation, and alkaline solutions but stable in acid conditions.

Recommended Dietary Allowances

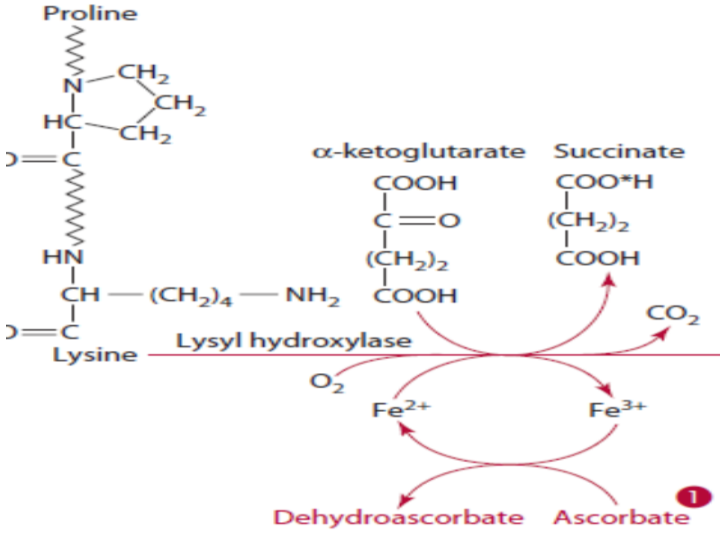
Adult male: 40mg/day.
Adult female: 40 mg/day.
Pregnancy: 60mg/day.
Lactation: 80mg/day.
Smokers: Extra 35 mg/day.
UL: Adult 2000 mg/day.

Functions of Vitamin-C

1. Collagen synthesis:

a. Most abundant protein found in the body.
b. Vitamin C is necessary for collagen synthesis.
c. Collagen is a structural protein found in skin, bones, tendons, and cartilage.
d. All collagen (n~19) has a triple helical structure.
e. For the collagen molecule to aggregate into its triple-helix configuration selected proline residues must be hydroxylated forming hydroxyproline.
f. Requires di-oxygenase enzymes, reduced iron (Fe+2), ascorbate.

Vitamin C role: During hydroxylation, iron cofactor in the enzymes is oxidized, (ferrous (2+) state ---- ferric (3+) state). Ascorbate is needed to function as a reductant thereby reducing iron back to its ferrous (2+) in prolyl and lysyl hydroxylases. Vitamin C may also influence mRNA levels needed for collagen synthesis. Although these reactions may see simple, normal development and maintenance of skin, tendons, cartilage, bone and dentine depend on an adequate supply of vitamin C. Also, important in wound healing and bleeding prevention from capillaries.



2. Carnitine Synthesis:

a. Carnitine is a methylated from nitrogen containing compound made from lysine.

b. Sufficient carnitine is critical in fat metabolism, because it is essential to transport long- chain fatty acids from cell cytoplasm into mitochondrial matrix where β-oxidation occurs.

Vitamin C role: Required for 2 hydroxylation reaction in synthesis carnitine, which functions as preferred reducing agent, specifically reducing Fe from ferric (Fe3+) back to ferrous state (Fe2+).

Tyrosine Synthesis

1. Hydroxylation of phenylalanine.
2. Requires phenylalanine mono-oxygenase (hydroxylase), Fe+2. O2. tetrahydrobiopterin, NADPH, vitamin C.
3. Vitamin C regenerating tetrahydro-biopterin from dihydrobiopterin.
4. Occurs in liver and kidney.
5. Tyrosine catabolism require ascorbate as reductant for hydroxylases.
6. Cu-dependent enzyme p-hydroxyphyenylpyruvate (dioxygenase).
7. Fe-dependent enzyme homogentisate dioxygenase.

Neurotransmitters

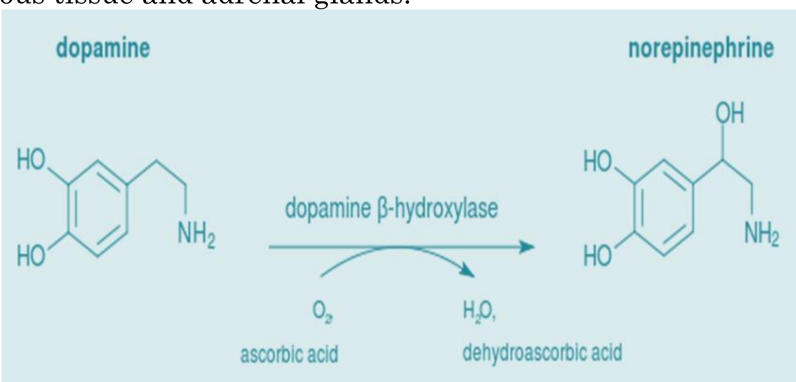
Vitamin C maintains mineral cofactors for some of the enzymes involved in synthesis of neurotransmitters in its reduced state.

1. Norepinephrine:

a. It is generated from hydroxylation of dopamine side chain.

b. This reaction catalyzed by dopamine monoxygenase (contain 8 Cu atoms)-vitamin C- dependent reaction.

c. Found in nervous tissue and adrenal glands.



2. Serotonin:

a. Hydroxylation of tryptophan (in brain).

b. Requires tryptophan mono-oxygenase (hydroxylase), O2 tetrahydrobiopterin, vitamin C. first step in serotonin synthesis.

Other Neurotransmitters and Hormones

keeping Cu in reduced for peptidylgycine α-amidating mono-oxygenase.
Many of amidated peptides are active as hormones, such as calcitonin, CCK and gastrin.
The enzyme found in pituitary, adrenal, thyroid glands and brain.

Microsomal Activity

1. A group of enzymes makes up a microsomal metabolizing system, mostly function in liver, to inactivate both endo-and exogenous substances.
2. Endogenous: Include various hormones and steroids (cholesterol).
3. Exogenous: xenobiotics (foreign chemicals) drugs, carcinogens, pesticides, pollutants, food additives.
4. The reactions to metabolize these substances usually involve hydroxylation's followed by other reactions to produce polar metabolites for excretion.

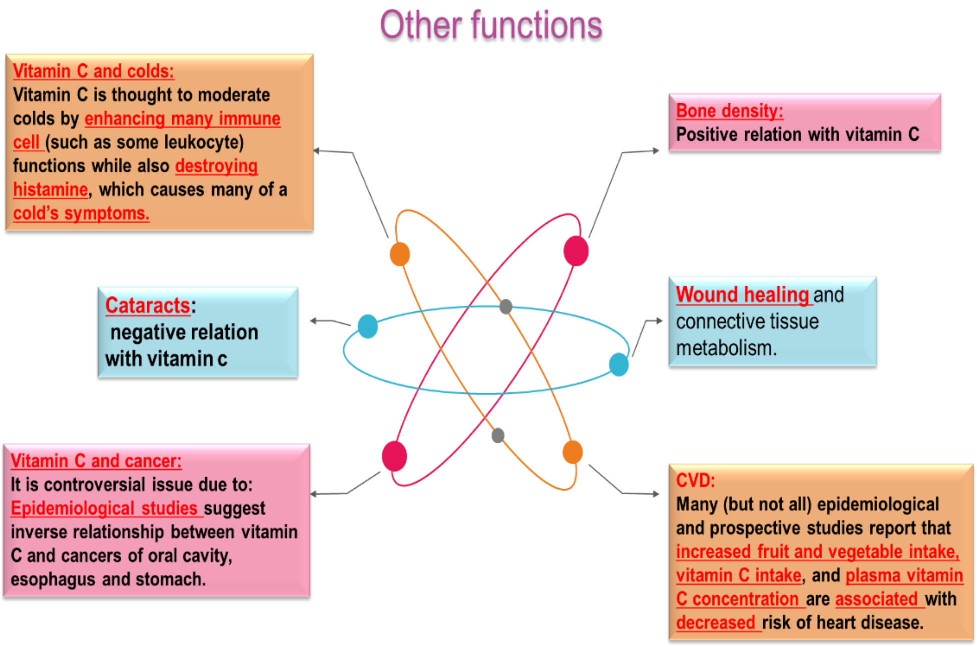
Antioxidant Activity

1. The reduction potential of ascorbate is such that it readily donates electrons/hydrogen ions to regenerate other antioxidants, such as vitamin E, glutathione, and uric acid, and to reduce numerous reactive oxygen (ROS) and nitrogen species (RNS).
2. Ascorbic acid interact with oxidants in the aqueous phase (blood or intracellular) before they initiate damage in nucleus, cell lipids.

Vitamin-C Reduces these Radicals Including

Hydroxyl radical(˙OH), a very reactive cenetred radical.
Hydroperoxyl radical (HO2˙), an oxygen centered radical.
Superoxide radical (O2˙), an oxygen centered radical.
Alkoxyl raical (RO˙), an oxygen centered radical.
Peroxyl radical (RO2˙), an oxygen centered radical.

Pro-Oxidant Activity



Vitamin C can reduce transition metals, while itself becoming oxidized to semidehydroascorbate:
Ascorbate (AH2) $+Fe^{3+}$ or Cu^{2-}

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Semidehydroascorbate radical (AH−) + Fe^{2+} or Cu^{1+}

These reduced metal ions can cause cell damage by generating ROS and free radicals.

Fe^{2+} or Cu^{1+} + H_2O_2 $\rightarrow$ Fe^{3+} or Cu^{2-} + H_2O_2 + OH

Fe^{2+} or Cu^{1+} + O_2 $\longrightarrow$ Fe^{3+} or Cu^{2-} + O^{2-}

Deficiency

Scurvy: Scurvy leads to formation of brown spots on skin, bleeding gums, small red skin discolorations caused by ruptured small blood vessels (petechiae), sublingual hemorrhages, easy bruising (ecchymoses and purpurae), impaired wound and fracture healing, joint pain (arthralgia), loose and decaying teeth, and hyperkeratosis of hair follicles, especially on the arms, legs, and buttocks.

Toxicity:

Toxicity symptoms:

a. Nausea, abdominal cramps, diarrhea, headache, fatigue, insomnia.
b. Hot flashes and rashes.
c. Aggravation of gout symptoms, urinary tract infections and kidney stones.
d. Upper limit: 2000mg/day.

Iron Absorption

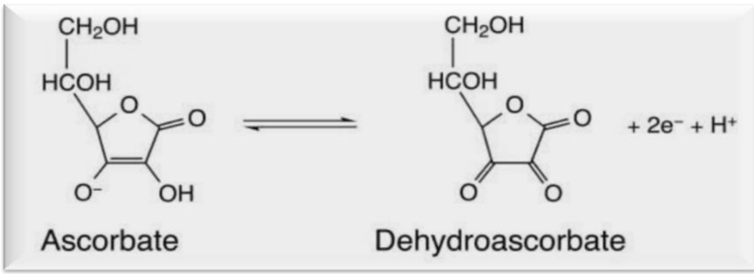
1. Iron absorption predominantly occurs in the duodenum
2. Iron in the diet comes in 2 forms: heme iron & non-heme iron
3. Non-heme iron is predominantly occurs in ferric form (Fe3+): must be converted into ferrous form (Fe2+).

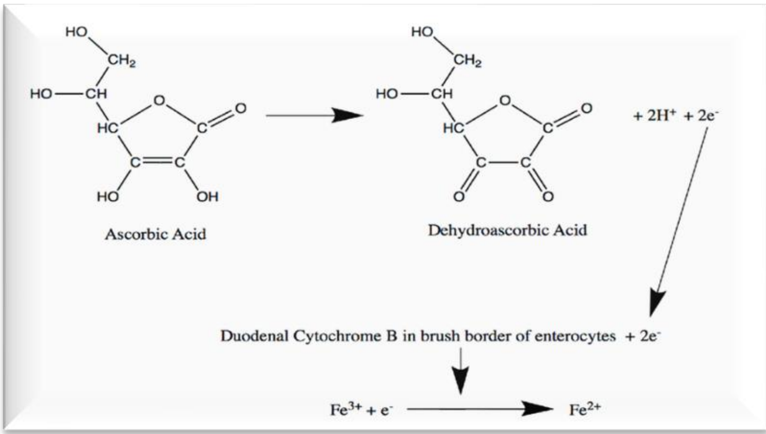
Heme iron is readily absorbed into enterocyte:

Dietary iron absorption is optimal with Fe2+, which may be important for anemia prevention.

Fe(3+) + Vitamin C $\longrightarrow$ Fe(2+) + DHA

The vitamin C is converted in this process to the oxidized form, dehydroascorbate (DHA).





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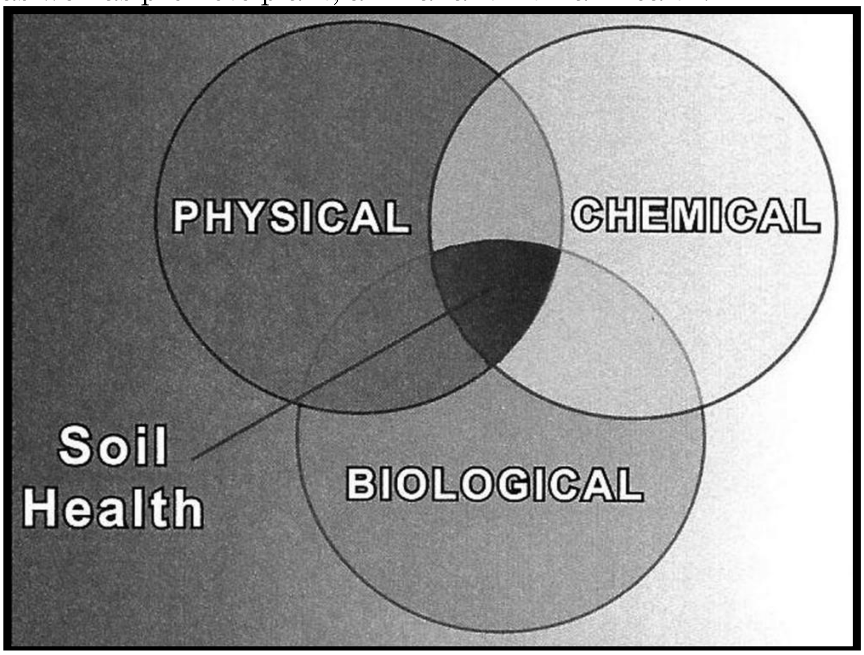
Deterioration of Soil Health and its Management

Article ID: 35052

Mrs. Bidusi Tripathy[1]
[1]Ph.D. Research scholar, Viswabharati University.

Introduction

Soil health comprises of two words- "soil" and "health". Soil is defined by the Soil Science Society of America (SSSA) as 'the unconsolidated mineral or organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. Health is defined by Merriam-Webster as 'the condition of being sound in body, mind, or spirit'. So "soil health" can be defined as 'the state of the soil being in sound physical, chemical, and biological condition, having the capability to sustain the growth and development of land plants. It refers to the capacity of soil to function as a vital living system, by re-organising that it contains biological elements that are key to ecosystem function within land-use boundaries. These functions are able to sustain biological productivity of soil, maintain the quality of surrounding air and water environments, as well as promote plant, animal and human health.



Integration of physical, chemical and biological components of soil

Soil Quality

Soil quality is the capacity of a soil to function for specific land uses or within ecosystem boundaries. This capacity is an inherent characteristic of a soil and varies from soil to soil. Such indicators as organic-matter content, salinity, tilth, compaction, available nutrients, and rooting depth help measure the health or condition of the soil-its quality-in any given place.

Soil Degradation

Soil degradation is defined as a change in the soil health status resulting in a diminished capacity of the ecosystem to provide goods and services for its beneficiaries. Degraded soils have a health status such, that they do not provide the normal goods and services of the particular soil in its ecosystem. The physical, chemical and biological status of the soil declines, thus resulting in deterioration of soil quality.

Causes of Soil Degradation

Soil degradation is caused by many factors, with some naturally-occurring, while human activities cause others. The leading causes of soil deterioration are wind and water erosion, deforestation, and urbanization.

Soil Quality Indicators

Soil quality indicators are used to evaluate how well soil functions since soil function often cannot be directly measured. Soil quality indicators may be qualitative (e.g., drainage is fast) or quantitative (infiltration= 2.5 in/hr).

There are three main categories of soil indicators: chemical, physical and biological. The table below shows the relationship between indicator type and soil function.

Indicator category	Related soil function
Chemical	Nutrient Cycling, Water Relations, Buffering
Physical	Physical Stability and Support, Water Relations, Habitat
Biological	Biodiversity, Nutrient Cycling, Filtering

Organic matter, or more specifically soil carbon, transcends all three indicator categories and has the most widely recognized influence on soil quality. Organic matter is tied to all soil functions. It affects other indicators, such as aggregate stability (physical), nutrient retention and availability (chemical), and nutrient cycling (biological); and is itself an indicator of soil quality.

Management of Soil Health

Managing for soil health (improved soil function) is mostly a matter of maintaining suitable habitat for the myriad of creatures that comprise the soil food web. This can be accomplished by disturbing the soil as little as possible, growing as many different species of plants as practical, keeping living plants in the soil as often as possible, and keeping the soil covered all the time. Soil chemical imbalances can be addressed through application of chemical amendments such as lime and fertilizer.

The following are important practices for soil health management.

1. Reduce Inversion Tillage and Soil Traffic: Excessive tillage is harmful to soil health in a number of ways. Tillage increases oxygen in the soil, stimulating microbial activity, and results in the decomposition of organic matter. Tillage also disrupts soil aggregates, exposing particles of organic matter that had been physically protected within aggregates to microbial consumption. If additions of organic matter are not sufficient to counteract the losses from decomposition, organic matter levels will decline over time, reducing soil health.

2. Increase Organic Matter Inputs: To maintain or increase soil organic matter levels, inputs of organic matter must meet or exceed the losses of organic matter due to decomposition. Healthy crops can be a valuable source of organic matter, and crop residues should be returned to the soil to the extent possible. Incorporation of cover crops or perennial crops and judicious additions of animal and green manure and compost can also be used to increase or maintain soil organic matter. Soil organic matter content can be monitored over time if you request an organic matter analysis when submitting soil fertility samples to your soil testing laboratory. Be sure that your organic matter comparisons over time are based on data from the same lab or from labs that use the same procedure for organic matter analysis, as results can differ significantly between analysis methods.

3. Use Cover Crops: Cover crops contribute numerous benefits to soil health. They keep the soil covered during the winter and other periods of time when crops are not growing, reducing the risk of erosion. The biomass produced by cover crops is usually returned to the soil, enhancing organic matter levels. Cover crops with taproots can create macropores and alleviate compaction. Fibrous-rooted cover crops can promote aggregation and stabilize the soil. Species of cover crops that host mycorrhizal fungi can sustain and increase the population of these beneficial fungi. Legume cover crops can add nitrogen to the soil through nitrogen fixation. Cover crops can retain nitrate and other nutrients that are susceptible to leaching losses.

4. Reduce Pesticide Use and Provide Habitat for Beneficial Organisms: Beneficial insects that contribute to biological control or pest organisms can be harmed by the application of broad-spectrum insecticides. Farmscaping is a whole-farm, ecological approach to increase and manage biodiversity with the goal of increasing the presence of beneficial organisms.

5. Rotate Crops: Diverse crop rotations will help break up soilborne pest and disease life cycles, improving crop health. Rotations can also assist in managing weeds. By growing diverse crops in time and space, pests that thrive within a certain crop are not given a chance to build their populations over time. Rotating crops can also help reduce nutrient excesses.

6. Manage Nutrients: Carefully planning the timing, application method, and quantity of manure, compost, and other fertilizers will allow you to meet crop nutrient demands and minimize nutrient excesses. Healthy, vigorous plants that grow quickly are better able to withstand pest damage. However, overfertilizing crops can increase pest problems. Increasing soluble nitrogen levels in plants can decrease their resistance to pests, resulting in higher pest density and crop damage.

Using diverse nutrient sources can help maintain soil health. Manure and compost add organic matter as well as an array of nutrients, but using just compost or manure to meet the nitrogen needs of the crop every year can result in excessive phosphorus levels in the soil. Combining modest manure or compost additions to meet phosphorus needs with additional nitrogen inputs from legume cover or forage crops in a crop rotation can help balance both nitrogen and phosphorus inputs.

Conclusion

Soil degradation is a genuine issue of the era which needs to be resolved with the development of latest technology and proper fertiliser application so as to restore the soil fertility and productivity. The policy formulation from government, the new research tools by scientists and their application by the growers and farmers, an integrated approach by all can help to counteract this problem.

Indicators Influencing Ease of Doing Business: A Review Report

Article ID: 35053

Sargam Swami[1], Swati Kumari[1], Kumar Varun Vijay[1], Gautam Kunal[2], Subhransu Nayak[3]
[1]Dept. of Agricultural Economics, Bihar Agricultural University, Sabour, Bhagalpur-813210.
[2]Deptt.of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal- 741252.
[3]Department of Humanities and Social Sciences IIT Roorkee, Uttrakhand India -247667.

Abstract

India has emerged as leading economic power in the world; it has shown significant improvement in World Bank's Doing Business Report which is the result of varied reforms undertaken by the Government of India in the form of Make in India, Digital India and Start Up India which has brought shift in the outlook of governance as the government has announced myriad of reforms aimed at upgrading the business environment in India with special emphasis on weak areas as spotted by World Bank. India holds 63rd position among 190 countries of the world; hence require further effort in manufacturing and credit system.

As, India is highly populated country, there are lots of challenges to be dealt to continue its commendable achievement. The paper analyses the index set by the World Bank on Ease of Doing Business and some major improvements done and looks in the key issues which need cardinal attention to make them of international level. Overall, it needs the active participation of government and citizens of the country for best performance in coming days.

Keywords: Ease of doing business, indicators, economic power, world bank.

Introduction

India has emerged as the world's fastest growing economy, owing to its strong democracy and powerful partnerships with international organizations. In recent years, the country has risen to become one of the world's most powerful trading nations.

The up gradation of business environment by facilitating finance and active role of regulatory bodies has given extra boost to the economy. Apart from that, government initiatives such as Make in India, Digital India, and Start up India have played an important role in ease of doing business, with the aim of transforming India into a manufacturing hub that will drive demand and induce growth by encouraging entrepreneurship and job creation.

According to the World Bank's recent report on Ease of Doing Business, India ranked 63rd out of 190 countries, representing a steady improvement since 2015, and it is the third year in a row that India has ranked among the top 10 improvers in the world, and it continues to rank first among South Asian countries.

There are many factors which influence the ease of doing business in any country viz., dealing with construction, cross-border trade, and resolving insolvency are some of them. So, in order to highlight the drivers involved in ascendancy of ease of doing business in India the present study was under taken.

Ease of Doing Business

Ease of Doing Business (EoDB), an index issued by World Bank annually emphasising the growth of businesses in any economy that provide support to government in addressing and overcoming economic challenges faced by the society like job creation, financial resource generation, and in improving the living standards of the citizen. Its assessment provides objective measures of business regulations and their enforcement across 190 economies on ten parameters affecting business through its life cycle. The Doing Business Report (DBR), a score that shows the gap of an economy to the global best practice as indicated in the table 1 in context of India.

Table 1: India's performance in World Bank's ease of doing business' report:

Sl. No.	Indicator (Ranking)	2016	2017	2018	2019	2020
1	Starting a business	164	155	156	137	136
2	Getting credit	36	44	29	22	25
3	Dealing with construction permit	184	185	181	52	27
4	Trading across border	133	143	146	80	68
5	Protecting minority investors	8	13	4	7	13
6	Getting electricity	99	26	29	24	22
7	Enforcing contracts	178	172	164	163	163
8	Paying taxes	156	172	119	121	115
9	Resolving insolvency	136	136	103	108	52
10	Registering property	138	138	154	166	154
India overall ranking in ease of doing business		134	130	100	77	63

Source: Ease of Doing Business in India, World Bank Group (pib.gov.in)

The increase in the ease of doing business ranking are basically calculated by sorting the aggregate distance to frontier scores on ten topics, each comprising of various indicators, allotting equal weight to each topic. The distance to frontier score aids in assessing the absolute level of regulatory performance and how it improves over time. Indicators which help in assessing the rank of ease of doing business of any economy is dealt herein.

Indicators Help in Assessing the Growth of Businesses in Any Economy

1. Starting a business: Since India is a developing country, starting a business has been difficult. However, since the launch of government initiatives such as Make in India and the Digital India campaign, it has become much easier for ordinary people to start their own businesses and operate in the economy's largest business city. Some relevant improvements undertaken are that; requirement of company seal and minimum paid up capital for company has been removed and online registration is required for ESI and EPF. SPICe has been brought in to handle all of the company's legal matters.

2. Getting Credit: This indicator demonstrates that obtaining credit has become institutionalised, as it measures both borrowers' and lenders' legal rights in relation to secured transactions and credit information. Some improvements have been seen such as secured creditors being given preference over government dues for easy recovery of their dues and coverage of security interest registration has been increased under SAFAESI Act.

3. Dealing with construction permits: This indicator put down all the procedures that are needed for a business in the construction industry and also concerned with quality control indices in building construction, insurance scheme, safety regime and certified professional qualification. For the time being, this indicator has improved and is implemented particularly in Delhi and Mumbai. The grant for construction permits, through online single window has streamlined the process in Delhi with reduction in cost of water and sewer by 90% and elimination of NOCs for zonal plan and property taxes dues. A third-party certification has been brought up in Delhi and Mumbai and the execution and tenure certificate has been consolidated into single certificate in Mumbai.

4. Trading Across Borders: It is primarily concerned with recording the amount of time and money spent on the process of exporting and importing goods. It is related with other things also such as domestic transport, documentary compliance and border compliance. Some major improvements are; the presence of Single Window Interface for facilitating trades with 24x7 customer's clearance facility. The time to import has been reduced to 265 days with the facility of direct port delivery up to 30% and direct port entry 70% (dipp.gov.in). The evaluation of risk-based imports and exports have been done through electronic Risk Management System and Parking Plaza has been developed at the JNPT port to reduce crowding.

5. Protecting minority investors: It deals with responsibility of measuring the protection of minority interest from inequality and shareholders rights in corporate governance. For this, Companies Act has been revised many times which has strengthened the minority investor protection in India. Some major improvements have been observed such as claims against defaulters are petitioned now. The constitution of National Company Law Tribunal secures shareholder protection.

6. Getting electricity: It refers to all the strategy needed by the business in getting permanent electricity connection and its supply for a standardized warehouse. The initiatives taken are reduced number of days of obtaining connection i.e., from 106 to 46 days (The world bank, 2021**)** and cost is also reduced and is conveniently made available to all the sectors of working environment.

7. Enforcing contracts: It helps in estimating the time and cost involved to sort out the commercial dispute through a local first- instance court, the quality of judicial processes index and examine whether each economy has acquired practices that assist good quality and efficiency in the court system. National Judicial Data Grid has been set up to look after the court cases.

8. Paying Taxes: This indicator accounts the taxes and statutory contribution that has to be made by firms in a given year and also deal with the firm's administrative charge of payment of taxes, contributions and facilitation of post filling procedures. Online payments for ESI and EPF contributions have been regulated.

9. Resolving Insolvency: This indicator is primarily concerned with the time, cost and recovery rate under the bankruptcy proceeding. It also emphasizes the outcome of insolvency proceedings which include domestic institutions and robust legal framework which is relevant to judicial liquidation and reform proceedings. Creditors are assigned significant role in decision making and restructuring of insolvent companies.

10. Registering Property: This indicator measures the time and cost and procedures which are required to register the commercial real estate. Many significant steps were taken to improve the mechanism of registering property as land records have been digitalized and are made publicly available with no extra cost, complaints regarding land can be made online on department's website and the revenue courts should dispose-off the cases related to land in a given time bound i.e., within a year from date of filing of report.

Constraints in Ease of Doing Business in India

The World Bank demonstrated that the lack of infrastructure, lower degree of innovation, complex regulatory measures, poor execution of tax system slow judicial system**s** are some of the basic causes for low ranking and poor growth pattern in India. The indicators that need peculiar attention that directly influence the activity of major population in starting a business, which needs high venture capital is cumbersome for ordinary citizen, getting credit in given time period, protecting minority investors which constitute major portion of the population, getting electricity at fair price and its proper distribution, enforcing proper contracts system so that commercial disputes can be controlled, paying taxes by employing online system and registering property in time and cost consuming procedure so to make it effective, it needs to be digitalized at each stage of governance.

The Way Forward

India is the fastest improving (growing) economy in the world and it is commendable that India has acquired 63rd position from consecutive improvement in last three years but the current ranking is not that satisfactory in terms of potential and size of the country (world bank). It has been observed that the indicators of ease of doing business are mostly confined to two jurisdictions, Delhi and Mumbai only so to determine the overall national business climate it requires standard shift in the outlook of governance as the government has announced myriad of reforms aimed at upgrading the business environment in India with special emphasis on weak areas as spotted by World Bank.

Conclusion

The EoDB ranking by World Bank is mainly based on an evaluation of business regulations and their implementation on ten parameters, and the procedure of indexing is confined to fixed topic therefore, it needs consideration of all social factors like the quality of human capital, size of the domestic market, incidence of corruption, policy standardization, the quality of the labour force which contributes significantly in creating the business environment. Thus, for analysing an inclusive view on the business environment of any nation, it needs involvement of all other factors that are examined under competitive and global index and global entrepreneurship index that is considered pivotal for preparing the layout for the nation's economic growth. Overall, it needs the active participation of government and citizens of the country for best performance in coming days.

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Status of Jute Production in Bihar

Article ID: 35054

Subhransu Nayak[1], Smita Susovita[2]
[1]Department of Humanities and Social Sciences (Economics) IIT Roorkee Uttarakhand India,
[2]Department of Agribusiness Management OUAT Bhubaneswar Odisha India.

Abstract

Jute is also known as 'golden fiber' and it is the second most important crop after cotton in India. The raw fiber extracted from jute has multiple uses, it is used for manufacturing various packaging materials for agricultural products, decorative, sacks, mats, ropes and geo-textile etc. India and Bangladesh are the topmost producer of jute in the world out of which India leads in jute production. In India West Bengal is the largest producer of jute followed by Bihar which lies second in jute production. Bihar which is the second largest producer of jute have cultivation area of 0.835 lakh hectares and production of 1.11 million bales (raw jute) and productivity of 2393 bales / hectare (DES, 2018, Bihar, Patna). Katihar, Purnea, Saharsa, Supaul and Madhepura are the major jute producing districts of the state. Katihar District was having the largest area grown for jute with 20638 ha, whereas production of jute was highest for Supaul with 50670 bales and productivity was highest for Madhepura with 6.64 bales/ha. In Bihar jute is still cultivated with traditional practices, the modern technological advancement has still not penetrated in their production process. There is a need for training the farmers in adoption of appropriate agro-techniques in production of the crop, so that the production efficiency could be increased. It is therefore necessary to identify the problems and provide necessary solution for the increment in jute production.

Introduction

Jute has been cultivated in India for centuries. Ancient history says during the era of the Mughal Emperor poor village people of India were using clothes made up of jute. Since ancient times people in Bengal were using ropes and twines which were made up of white jute for rituals, ceremonies, festivals and different household purposes. It is the second most important natural fiber produced in India after cotton (www.nirjaft/publication). It is also known as 'golden fiber' and is used for manufacturing different type of packaging materials for agricultural and industrial products. It belongs to family *Tiliaceae* and fiber is obtained mostly from two important commercial species which are White jute (*Corchorus capsularis)* and Tossa jute (*Corchorus olitorius).* Jute fiber have several uses ranging from low value geo-textiles to high value carpet, apparel, composites, decorative, furnishings, sacks, mats, bags, tarpaulins and ropes etc. The tender leaves are consumed as vegetables; the stick which is recovered after fiber extraction is used as domestic fuel and also as a building material for huts in rural areas. Jute is highly rich in beta carotene, vitamin C and phenols. In this present scenario many cheaper substitutes of this natural fiber which are non-biodegradable that has resulted in growing environmental concern. It is an important crop of South-East Asia, mostly produced in India and Bangladesh India was the world's largest producer of raw jute and jute products; it contributed to 50 percent of raw jute and 40 percent of jute products out of total global production. India produced 10.14 million bales (1 bale=180 kg jute fiber) of raw jute (DES, 2018). It covers 0.4 to 0.5 % of total area of the country and contributes about Rs 7000 crores (0.32 %) of India's total value of output from agriculture (CRIJAF, 2019)**.** In India West Bengal is the largest producer of jute followed by Bihar which lies second in jute production.

Status of Jute Production in Bihar

Bihar is the second largest producer of jute, with cultivation area of 0.835 lakh hectares and production of 1.11 million bales (raw jute) and productivity of 2393 bales / hectare (DES, 2018, Bihar, Patna). The districts of Katihar, Purnea, Saharsa, Supaul and Madhepura are the major jute producing districts of the state. The state is also among flood prone state of the country, especially zone II of the state. Flood damages the standing crops and creates a huge loss to the state's economy of Bihar. Although flood usually damages the crops in general but as compared to other crops the recovery rate of harvesting for jute is high. The major constraint in jute cultivation in Bihar is reported to be the lack of knowledge of recommended practices for jute. There is also lack of promotion in production of jute-based products in the state. The state acts only as a supplier of raw material and no value addition is done, primarily due to lack of jute processing industry.

Table 1: Area, Production and Productivity of Jute in Bihar:

Year	Area ('000ha)	Production ('000 bales)	Productivity (kg/ha)
2008-09	121	971	1361
2009-10	123	1118	1637
2010-11	127	1164	1642
2011-12	129	1490	2079
2012-13	123	1490	2180
2013-14	104	1498	2571
2014-15	94	1418	2694
2015-16	93	1308	2508
2016-17	91	1356	2671
2017-18	83	1110	2393

Source: DES, Ministry of Agriculture and Farmer welfare.

The area, production and productivity of jute in Bihar is presented in Table 1 and Fig.1. In Bihar, there was a declining trend in area of jute but the production and productivity showed an increasing trend which may be due to the interest and awareness of farmers for the cultivation of jute.

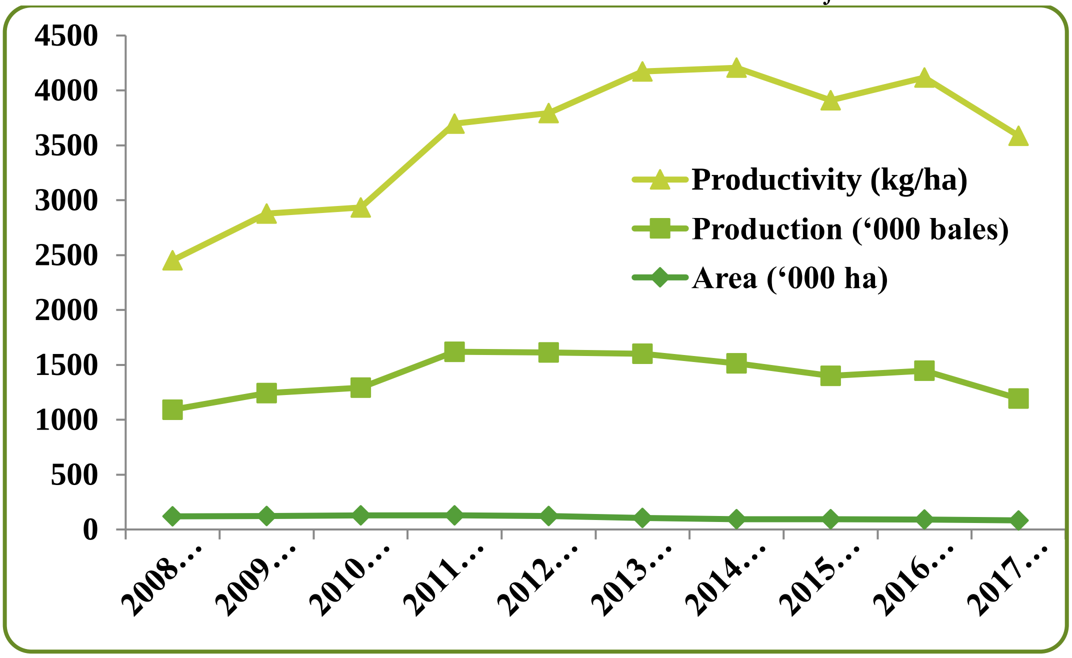

Fig. 1: Area, production and Productivity of Jute in Bihar.

Table 2: Area, Production and Productivity of jute in major producing Districts of Bihar (2017-18):

Sl. No.	Name of District	Area (ha)	Production (bales)	Productivity (bales/ha)
1.	Araria	15693	27494	1.75
2.	Katihar	20638	20948	1.02
3.	Kishanganj	14977	20878	1.39
4.	Madhepura	5536	36759	6.64
5.	Purnia	12272	42989	3.50
6.	Supaul	14354	50670	3.53

Source: DES, Government of Bihar.

Table 2 indicates the area, production and productivity of major jute growing states of Bihar in 2017-18. Katihar District was having the largest area grown for jute with 20638 ha, whereas production of jute was highest for Supaul with 50670 bales and productivity was highest for Madhepura with 6.64 bales/ha.

Conclusion

In Bihar jute is still a crop which is cultivated with traditional practices, the modern technological advancement has still not penetrated in their production process. The resource allocation and resource use efficiency of farmers producing jute is very less. Jute is a labor intensive crop and there is scarcity of labor during peak period, harvesting ,retting process of jute and most of the labor used was not judiciously used hence the cost of cultivation is always enhanced enormously .The marginal and small farmers are unable to bear the transportation cost hence cannot sell their produce at distant market with good prices, ultimately suffer huge loss in selling their produce in local markets at relatively cheaper prices .Majority of farmers are exploited by middle-men because of lack of market information and less knowledge about different grade of jute. The raw jute cultivated in the state is exported to West Bengal as there is lack of jute processing mills in the state. There is also need for training the farmers in adoption of appropriate agro-techniques in production so that the production efficiency could be increased. There are several malpractices done by mill owners in using unscientific techniques for measuring the moisture percentages that need to be checked by higher authorities and procurement technique followed by JCI need to be considered. It is therefore necessary to identify the problems and provide necessary solution for increment in jute production and trade to bring back the past glory of jute production in the state as well as in the country.

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Climate Change, Food Insecurity and India's Agriculture Sector

Article ID: 35055

Swati kumari[1], Sargam Swami[1], Subhransu Nayak[2], Kumar Varun Vijay[1]
[1]Department of Agricultural Economics Bihar Agricultural University Sabour Bhagalpur.
[2]Department Humanities and Social Sciences (Economics) IIT Roorkee Uttarakhand India.

Abstract
The effects of climate change are being seen in different forms all over the world. Obviously, this is also having an impact on a country like India. This country, which is mainly dependent on the weather for agriculture, will have to be prepared to deal with its serious consequences in the coming times because on one hand it will affect the income of a large population of India engaged in agriculture and on the other hand it will cause food insecurity. It will weaken our fight against poverty and hunger. The recent reports of the IPCC and SOFI are of great importance for India and suggest that there is a need to further accelerate efforts to address the risks of climate change. This article describes its impact on the agricultural sector of India, mentions the efforts being made by India to reduce these negative effects. By evaluating the current efforts, we can have a proper brainstorming about the next steps.

Keywords-. Pre-industrial period, Greenhouse emissions, Alternate Wetting Drying, Direct-Seeded Rice.

The effects of climate change are being seen in different forms all over the world. Obviously, this is also having an impact on a country like India. This country, which is mainly dependent on the weather for agriculture, will have to be prepared to deal with its serious consequences in the coming times because on one hand it will affect the income of a large population of India engaged in agriculture and on the other hand it will cause food insecurity. It will weaken our fight against poverty and hunger. The recent reports of the IPCC and SOFI are of great importance for India and suggest that there is a need to further accelerate efforts to address the risks of climate change. This article describes its impact on the agricultural sector of India, mentions the efforts being made by India to reduce these negative effects. By evaluating the current efforts, we can have a proper brainstorming about the next steps.

Climate change is one of the biggest challenges for the whole world. The challenge becomes even more worrying for agricultural country like India having huge population, as the negative impact of climate change on agriculture can lead to food insecurity. Currently, the Covid pandemic has added fuel to the fire in increasing hunger. In such a situation, India will have to speed up its developmental work on the one hand and on the other hand, proper development of the Indian agricultural sector will have to be done while making every effort to deal with climate change.

Impact of Climate Change on Agriculture
Dependence on monsoon is an important feature of agriculture in India. The amount of rainfall affects the yield of agriculture. Agriculture in India is considered a gamble of monsoon. Climate change has deepened the crisis of monsoon uncertainty.

The soil moisture is decreasing and the concentration of carbon dioxide in the atmosphere is increasing, due to which the amount of protein and other nutrients is decreasing in most of the food crops like rice and wheat. It is like a curse for India battling malnutrition.

According to the IPCC report, global warming will exceed 1.5 degrees in the 2030s. If carbon dioxide and other greenhouse gases are not reduced, the temperature will be 2°C above the 'pre-industrial period'(AR6 Climate Change 2021).

Due to this, the agriculture sector will have to face extreme conditions like frequent floods, droughts and storms. Talking about India's perspective, its effect will be visible in the form of floods in the northeastern part of the country, cyclones in the eastern coastal region, heat waves in the northern and central parts and drought in the north-west part. Animal husbandry is also being affected due to hot waves. Fertility and milk production of animals are decreasing.

It is known from the estimates of IARI that there is a decrease of 4-5 million tonnes in wheat production due to increase in temperature by one degree Celsius.

The institute has projected a decline of up to 10 percent in the irrigated rice yields by 2080 due to the increasing temperature (Climate Change and Indian Agriculture).

As per information given by union minister of agriculture and farmers welfare in Lok sabha in the month of February of this year (PIB Delhi 9 February 2021).

Rainfed rice yields in India are projected to reduce marginally (<2.5%) in 2050 and 2080 and irrigated rice yields by 7% in 2050 and 10% in 2080 scenarios. Further, wheat yield projected to reduce by 6-25% in 2100 and maize yields by 18-23% (PIB Delhi 9 February 2021).

The global pandemic has deepened the crisis of food insecurity, although even before this pandemic, India had the largest number of malnourished people in the world. Significantly, India is one of the countries with the largest food reserves in the world (120 million tonnes as of July 1, 2021). As per latest report of SOFI for 2021 mentions that moderate to severe food insecurity has seen an increase of around 6.5 percent over the period 2018 to 2020 (FAO).

On analyzing the above data and facts, two things come to our notice. Firstly, climate change will badly affect agricultural productivity in the coming times and secondly, India will have to meet the basic needs of its huge population in future. At the same time, while strengthening the economy of the country, it has to be oriented on the path of development. To maintain its food security, India has to be prepared because the horrors of Bengal famine still exist in the womb of history.

In such a situation, India will have to maintain high agricultural income and nutritional level while imbibing the concept of sustainable development. Along with the modernization of agriculture, changes in the food pattern are also expected. Both 'quality of food' and 'quantity of food' have to be taken care of. Along with rice, wheat, millets, pulses, oilseeds and other horticultural crops will also have to be given attention. It is a good thing that in the financial year 2020-21, India's agricultural exports reached $ 41.8 billion (Economic survey 2020-21) but rice contributed the most to the export of these agricultural commodities. It is worth noting that environmental sustainability concerns are always there in the production of rice and sugar. A lot of water is consumed in their production. In addition, rice cultivation contributes about 18 percent to greenhouse emissions. Rice cultivation should be water-efficient and with low greenhouse gas emissions. For this, we have to adopt farming methods like Alternate Wetting Drying-AWD, Direct-Seeded Rice (DSR) and micro-irrigation as soon as possible. Efforts like 'Climate Change Fund' and 'National Adoption Fund' by NABARD are commendable steps.

Therefore, it is clear that the goal of maintaining food security can be achieved only when India's agriculture will be able to bear the risk of climate change and will strive towards reducing the causes responsible for climate change.

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Problems and Prospectus of Jute Industry in India

Article ID: 35056

Subhransu Nayak[1], Smita Susovita[2], Swati Kumari[3], Sargam Swami[3], Ramnath K. Ray[4]
[1]Department of Humanities and Social Sciences (Economics) IIT Roorkee Uttarakhand India.
[2]Department of Agribusiness Management OUAT Bhubaneswar Odisha India.
[3]Department of Agricultural Economics BAU Sabour Bhagalpur.
[4]Senior Research Fellow, ICAR Research Complex for Eastern Region, Patna, Bihar.

Abstract
The Jute industry occupies an important place in contributing to the the national economy of India. Jute is used extensively in the manufacturing of different types of fabrics, manufacturing of Hessian, sacking, carpet, mats, bags and ropes. It is one of the major growing industries in the eastern part of the country, particularly in West Bengal. It contributes about 50 per cent of raw jute and 40 per cent of jute products to the total global production. India produced approx 10.14 million bales (1 bale=180 kg jute fiber) of raw jute (DES, 2017-18). Jute covers around 0.4 to 0.5 per cent of total area in the country which contributes about Rs 7000 crores which was 0.32% of India's total value of output from agriculture (CRIJAF, 2019). It provides livelihood to over 4 million farmers and their families across the country. Its production and processing provide employment to more than 4.0 lakh people (CRIJAF 2019). The major challenges in jute industry in India are mostly stiff competition in the international Market, substitute materials for jute fiber, low yield per acre of jute, lack of modernization in technology adopted for jute. The jute industry has very high potential need to be revived by taking major steps in producing jute diversified products, jute procurement should be increased by government when market price for raw jute is low, government should come up with new schemes that will boost the growth of the industry and increase in research and development of technologies relating to jute industry will definitely contributes to its growth. It is therefore necessary to identify the problems and provide efficient solution for enhancement in jute cultivation and trade to bring back the past glory of jute production in the state as well as in the country.

Introduction
Jute (*Corchorus spp.*) is the second most important natural fiber produced in India after cotton. It is also known as 'golden fiber' and is used for manufacturing different type of packaging materials for agricultural and industrial products. It has been observed during last few decades the uses of synthetic fiber have been increased that have degraded the environment. Jute has a greater advantage over synthetic fiber in being biodegradable, recyclable and environmentally friendly fiber. It is the one of the major crops of South-East Asia, mostly produced in India and Bangladesh. It is also being cultivated on a smaller scale by countries like china, Pakistan, Thailand, Myanmar, Nepal and Bhutan. India is the world's leading producer of raw jute and jute products; it contributes about 50 per cent of raw jute and 40 per cent of jute products to the total global production. India produced approx 10.14 million bales (1 bale=180 kg jute fiber) of raw jute (DES, 2017-18). Jute covers around 0.4 to 0.5 per cent of total area in the country which contributes about Rs 7000 crores which was 0.32% of India's total value of output from agriculture (CRIJAF, 2019). It provides livelihood to over 4 million farmers and their families across the country. Its production and processing provide employment to more than 4.0 lakh people (CRIJAF 2019). Presently the jute industry is facing stiff competition with its cheaper substitutes like plastic bags and the farmers are not getting remunerative prices for the fiber they produce.

The Jute industry occupies an important place in the enhancing the national economy of India. Jute is used extensively in the manufacturing of different types of traditional packaging fabrics, manufacturing of Hessian, sacking, carpet, mats, bags and ropes. It is one of the major industries in the eastern part of the country, particularly in West Bengal, it meets all the required standards for 'safe' packaging in view of being a natural, renewable, biodegradable and eco-friendly product. There are 94 composite jute mills out of which the state of West Bengal has 70 jute mills with Andhra Pradesh having 10 mills, Uttar Pradesh 3 mills, Bihar 3 mills, Orissa 3 mills, Assam 2 mills, Chhattisgarh 2 mills and Tripura 1 Jute Mill. The first Jute Mill was established at Rishra, on the River bank of Hooghly near Kolkata, in 1855.

Problems of Jute Industry in India

1. Stiff competition: Bangladesh, Sri Lanka, Thailand and China are recently giving great threat to India in International export market. The net value of export is increasing day by day but India's percentage share in world production is gradually decreasing. India is the second largest exporter of jute goods in the world. Due to its tough competition with Bangladesh which is largest exporter of jute goods with a share of 75.5 per cent out of total export of jute goods in global market. India's share in the world export thas declined from about 80 per cent in 1960-61 to about 65 per cent in 1980-81. The main buyers of the Indian jute goods are USA, Russia, Germany, UK, Australia, Argentina, Myanmar and Singapore.

2. Substitute Materials: Emergence of substitute goods against gunny bag which created a huge loss of demand for jute goods both at domestic and international market these substitutes are synthetic bags which are cheaper than the traditional jute bags. The industries which used jute bags earlier have substituted over synthetic bags for reducing their production cost ex- the cement factories are using synthetic bags instead of jute bags even the food grains packaging is done in plastic bags which are a substitutes for jute bags ,that have bring down the demand of jute in the International market .These synthetic bags are non-biodegradable which produces a negative impact to environment but the firms prefer it instead of jute bags to reduce their production cost on the other hand jute bags are completely degradable and environmental friendly but are not preferred by present day firms.

In order to protect the interest of farmers and to stabilize the jute industries government has made certain policies regarding compulsory uses of jute bags in procurement, storage and marketing of food grains. These policies are needed to boost up the jute industry as substitute are dominant in the current market. Presently jute products face a huge competition with these cheaper substitutes and there is requirement for revamp of jute industry with help of government in putting their efforts towards it.

3. Low yield per acre: India produces very low quantity of jute per unit land. In fact, among the jute producing countries, Indian production of jute is, perhaps one of the lowest. In Bangladesh the average yield is comparatively higher than India which clearly shows there is ample scope in increasing the productivity of jute in India, which would in turn increase the global production of jute and stabilize the competition for jute in world jute market.

4. Growth of jute mills in Bangladesh and loss in foreign market: Newly started jute industry in Bangladesh has captured some market of Indian jute goods which have created a huge competition for Indian jute in the international market. Previously more of the raw jute are supplied by Bangladesh to India for the working of jute mills in India, now due to growth of jute mills in Bangladesh which have made the situation even worse for the Indian jute Industries, leading to frequent closure of jute industries and global reduction of jute goods and raw jute in India.

5. Lack of Modernization: Most of the jute industries in India are old they are built around 100 to 150 years back. Naturally these mills have backdated machinery which need to be upgraded. These machineries have less capacity and less power compared to modern technologies, because of use of these productive capacity has been gradually declined resulting a huge gap in production of jute goods and declined demand of Indian jute produces in world market.

6. Effect of Partition: Due to partition in 1947, the good jute producing areas went to east Pakistan presently (Bangladesh) which received 80 per cent of good quality jute growing areas but 95 per cent of the jute mills retained in India leading to huge demand of raw jute which was imported from Bangladesh to meet the requirement of the jute mills. Due to this Indian jute industry faced huge problems in producing jute products, as the imports of raw jute was costlier and hence the jute products obtained were costly which reduced the demand of Indian jute goods in international market.

Measures for Reviving the Jute Industry

1. Jute Product Diversification: The main products manufactured out of jute majorly are sacks and hessian, constituting of about 90 per cent of total jute products. The main reason for higher share of sacks is due to demand of it under JPM Act, 1987 which have been increasing due to increase in production and procurement of food grains. Jute Diversified Products example Handloom, Handicraft share is only 10.3 per cent, therefore emphasis need to be laid on product diversification to bring out many new non-conventional products with several new technologies

2. Jute Procurement: Strengthening JCI Infrastructure: JCI undertakes MSP operation through its 16 regional offices ,141 DPCs and State Cooperative Societies in different jute producing states. Jute procurement by JCI have been less than 4 per cent of jute produced during the last 5 years. However ,present total storage capacity available with JCI is not adequate enough to meet the procurement demand, JCI have to make major Intervention under MSP operation to potect the interest of jute growers .Shortage of manpower due to less number of employees working and ban on recruitment since 1991 has affected its operational activities .Many of JCI are not present in the remote areas due to which many farmers not able to sell their produce at MSP and have to sell their produce to the local traders at much lower prices. The JCI need to be strengthened for effective procurement operations in the interest of farmers. PACs, SHGs, FPOs could also be involved in procurement operation to increase the procurement of jute.

It was seen that farmers are being exploited by the mills in using unscientific use of moisture meters that measures moisture content of fibre higher than actual and farmers are underpaid due to it. Such things need to looked over, there should be trust between the farmers and millers. These practices should be seen as a serious concern and the mill owners should use moisture machines (electrodes) which are used by JCI and necessary guidelines need to be followed while procurement.

Steps Taken by Government to Revamp the Jute Industry

Some schemes have been developed for the development and diversification in the jute Industry sector. Jute handlooms, handicraft was priotized.

Government have implemented many schemes to support the jute manufacturing units and to strengthen the jute sector.

1. Incentive Scheme for Acquisition of Plants and Machinery (ISAPM):
2. Government of India launched ISAPM for Jute Industry and Jute Diversified Products Manufacturing Units. The basic aim of this scheme was to facilitate modernization in existing and new jute mills and up-gradation of technology in the existing jute mills and to provide assistance to a large number of entrepreneurs to manufacture value added biodegradable jute.
3. When the market price of raw jute falls below a certain level, the jute corporation of India (JCI) procures raw jute at minimum support price (MSP),
4. Fixed on the basis of recommendation of (CACP), from jute growers to safeguard their interest. Government of India have sanctioned Rs 204 crores for four years starting from 2014-15 to enable JCI to be ready for MSP operations.
5. Under the jute Packaging Materials (Compulsory use in Packing commodities)
6. (JPM Act), 1987, Government specifies the commodities and the extent to which they are mandatorily required to be packed in Jute Packaging Materials.
7. Presently, a minimum of 90 per cent of food grains and a minimum of 20 per cent of sugar are to be compulsorily packed in jute sacking.
8. Jute –ICARE (Jute: Improved Cultivation and Advanced Retting Exercise).

This pilot project launched in 2015 was aimed for addressing the difficulties faced by the jute cultivators by providing them certified seeds at subsidized price, seed drills to facilitate line sowing, nail-weeders to carry out periodic wedding and popularizing several newly developed retting technologies under water limiting condition. That has resulted in increase in returns to jute farmers.

Conclusion

In the current scenario there is a urgent need of boosting the jute production, jute product diversification in order to combat the global competitiveness and to increase overall share of global jute trade for India. India was the second largest exporter of jute goods in the world due to its tough competition with Bangladesh which was largest exporter of jute goods with a share of 75.5 per cent out of the total export of jute manufactured products in global market. Jute growers are facing problems of low water scarcity and long-time duration of retting that can be solved by using recent technologies that can increase the production of jute sector, there should be awareness of such technologies. The malpractices done by mills in using unscientific techniques for measuring the moisture percentages need to be checked by higher authorities and procurement technique followed by JCI need to be considered Jute procurement by JCI has been less than 4 per cent of jute produced during the last 5 years. Effective implication of policy should be done to protect the interest of jute growers in getting remunerative price for the fibre they produce. JCI should immediately procure produce from farmers when there is reduction of jute prices below MSP. Awareness of the presently running government schemes should be done to that farmer so that should be benefited out of it. It is therefore necessary to identify the problems and provide efficient solution for increment in jute cultivation and trade to bring back the past glory of jute production in the state as well as in the country.

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Toxins in Plant Pathogenesis

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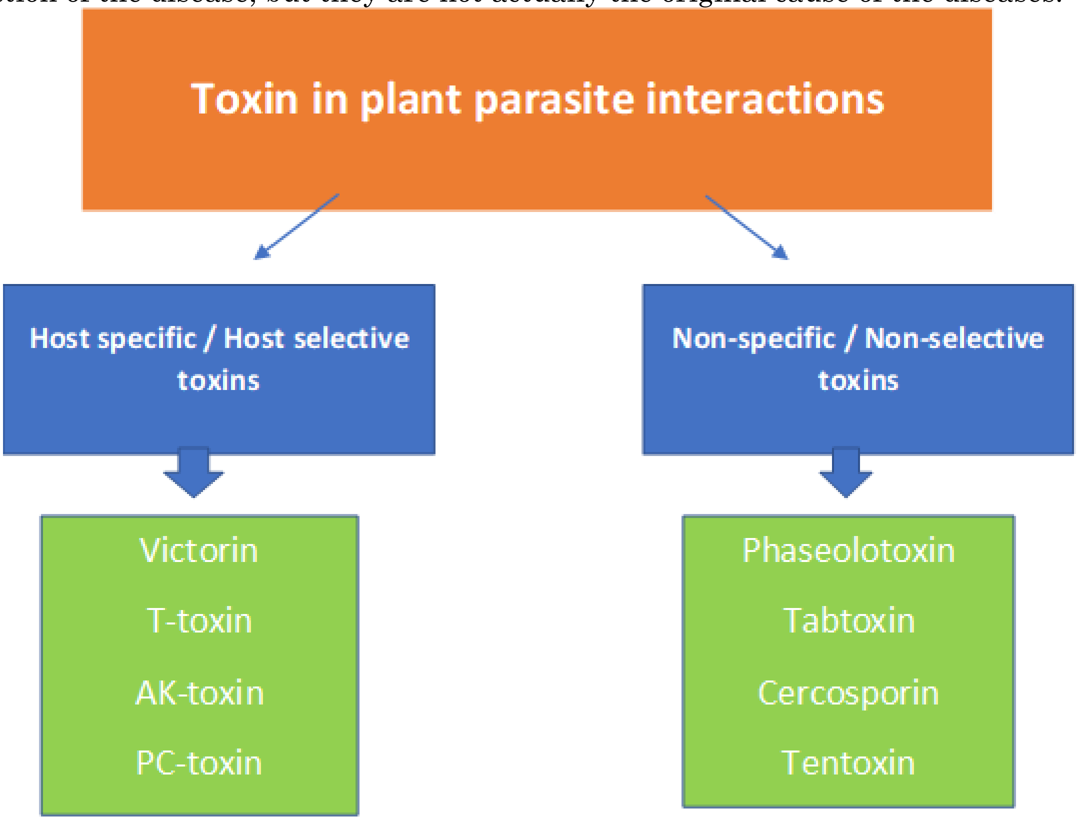
Yogita Nain[1], Deependra Singh Shekhawat[1]
[1]Ph.D. Scholar, Plant Pathology, RARI Durgapur, Jaipur, 302018, Rajasthan.

In pathology toxins are low molecular weight, non-enzymatic pathogenic substances produced by fungi and bacteria. The term toxin is used for a pathogen product, or even a very low-level pathogen host interaction that works directly on the host protoplasm to influence disease progression or symptom manifestations. The toxin acts directly on the protoplast and interferes with permeability or its membrane.

The Toxin Classification is Divided Into 3 Broad Categories

1. Pathotoxins: These are toxins that play a major role in disease production and produce all or most of the disease symptoms in the affected plants.
2. Phytotoxins: These are toxins that produced in the host plant as a result of host-pathogen interactions where the suspected role of the disease is rather suspended.
3. Vivo Toxicity: These are substances produced by the host with a pathogen and / or its host that works in the production of the disease, but they are not actually the original cause of the diseases.



Classification Based on Specificity of Toxins

1. Host specific / Host selective toxins: A product produced by a pathogenic microorganism only works on a specific host of pathogen and produces all the symptoms of the disease. This is the basic diagnosis of diseases. Eg: Victorin, T-toxin, Phyto-alternarin, Amylovorin.

Host selective toxins	Producer organism	Disease/ host
Victorin	*Cochliobolus victoriae*	Victoria blight of oats
HC-toxin	*Helminthosporium carbonum* race 1	leaf spot disease in maize
HS-toxin	*Cochliobolus sacchari*	Eye spot disease of sugarcane
AK-toxin	*Alternaria alternata*	Japanese pear black spot disease

T-toxin	*Cochliobolus heterosporus*	Southern corn leaf blight
PC-toxin	*Periconia circinata*	Grain sorghum

2. Non-specific / Non-selective toxins: These are non-specific toxic products of the pathogen; these are secondary determinant of disease. Ex: Ten-toxin, Tab-toxin, Fusaric acid, Piricularin, Lycomarasmin and Alternaric acid.

Non-selective toxins	Producer organism	Disease/ host
Tentoxin	*Alternaria alternata*	Seedling chlorosis of several plant
Tabtoxin	*Pseudomonas syringae* pv. tabaci.	Wildfire disease of tabacco
Phaseolotoxin:	*Pseudomonas syringae* pv. Phaseolicola	Blight in beans
Cercosporin	*Cercospora* sp.	
Fumaric acid	*Rhizopus* spp	Hull rot disease of almond
Alternaric acid	*Alternaira* spp	

Some Host Specific / Host Selective Toxins

Victorin- Victorin is produced by *Cochliobolus victoriae (Helminthosporium victoriae*) fungi in 1945. The fungus is carried by the soil, seed and infect the basal portion of susceptible plant. Luke and Wheeler, (1954) gave the name "victorin". It is a complex chlorinated cyclic pentapeptide. The toxin main target is plasma membrane. The effective concentration of victorin is 2×10^{-4}µg/ml.

HC-toxin: HC-toxin is produced by *Helminthosporium carbonum race 1*, which causes leaf spot and ear mold disease in corn. HC toxin host specific in nature, which is toxic only on specific maize lines. Toxin inhibits the enzymes histone deacetylases. Inhibition of deacetylases also interferes with Défense genetic expression. The effective concentration of HC-toxin is 0.2µg/ml.

T-Toxin: The fungus *Cochliobolus heterostrophus* formerly known as *Helminthosporium maidis* produce Southern Corn Leaf Blight in maize. The toxin directly affects the mitochondria of the affected cells where ATP binding is inhibited.

Some Non-Specific / Non-Selective Toxins

Tentoxin: Toxin is produced by the fungus *Alternaria alternata*. Causes spot and chlorosis in plant. The toxin is a cyclic tripeptide that binds to and disables a chloroplast-coupling factor protein. That involved in energy transfer and as well as inhibition of light dependent phosphorylation of ADP to ATP. The effective concentration of tentoxin is 2µg/ml.

Tabtoxin: Toxin is produced by *Pseudomonas syringae pv. tabaci*. poisons associated with "wildfire disease of tobacco". Symptoms of the disease are leaves showing necrotic areas surrounded by a yellow halo. In the host cell, the toxin is hydrolysed by aminopeptidases and tabtoxinine is released. Tabtoxinine causes chlorosis and necrosis. It prevents the enzyme glutamine synthetase.

Phaseolotoxin: Toxin is produced by *Pseudomonas syringae pv. Phaseolicola*. The toxin involved in bacterial bean blights disease called "halo blight. It inactivates enzyme ornithine carbamoyl transferase and inhibiting amino acid synthesis.

Cercosporin: cercosporin produced by *cercospora* species. Cercosporin is a photoactivated toxin, which becomes nontoxic in dark.

Role of Toxins in Pathogenesis

1. Toxins are produced by phytopathogenic fungi and bacteria.
2. Toxins play major role in suppression of plant defence mechanism
3. Toxins directly kill host protoplast.
4. Changes cell permeability.
5. Inhibition of host enzyme - tab toxin inhibit normal host enzymes.
6. The cellular transport system, in particular, the exchange of H + / K + in the cell membrane is affected.
7. Causes loss of water and electrolytes and unrestricted entry of substances including toxins.

8. Hydrolysis protoplasmic proteins.

Conclusion

Toxins are small metabolites involved in the formation of plant diseases. Toxins are a weapon of microbes, which help to damage and kill the host cell. They cause great damage to the plant and produce a variety of symptoms. It inhibits the enzymatic reaction of the receptor. The toxin acts at low concentrations and acts directly on the host protoplast.

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Omics Approaches in Agriculture

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Nabarun Roy[1], Mallar Kanti Nath[2], Prasenjit Debnath[3], Dipen Namah Adhikari[1]
[1]Department of Agricultural Biotechnology, Assam Agricultural University, Jorhat, Assam-785013.
[2]Division of Plant Breeding, ICAR Research Complex for NEH Region, Tripura Centre, Lembucherra, Tripura- 799210.
[3]Department of Horticulture, College of Agriculture, Lembucherra, Tripura-799210.

Introduction

Agricultural production is facing a huge challenge to feed the increasing world population. Around 7.8 billion people are living in this world in the 3rd decade of the 21st century which is expected to hit 9.8 billion in 2050. With limited area of cultivation and water resources available, it is the need of the hour to increase the agricultural production with minimum negative effects on the ecosystem. At present global agriculture is confronting a serious threat from climate change in the name of stress, which is anticipated to bring in reduced productivity. In this present context, the field of crop improvement has significantly contributed towards food security with the help of biotechnology tools such as omics technologies and breeding of climate smart crops. Progress in omics technologies has provided new concepts and tools that promise to accelerate crop improvement programme more precisely and efficiently (Boopathi, 2020). The use of omics tools with its different subjects such as genomics, transcriptomics, proteomics, metabolomics etc. and even a combined use of all of them (panomics) has contributed to the enhancement of agricultural production, quality, taste, nutritional composition of food crops, their protection from different biotic and abiotic stresses and thus significantly affected agricultural economics. The different field of omics and the different tools used in those fields are reviewed briefly below.

Genomics

It is the field of study of all the genes in a given genome including the identification of gene sequences, intragenic sequences, gene structures and annotations. Rapid developments in genome sequencing technology led to the advancement of genomics which began in the 1970s (first generation DNA sequencing), continued into the mid-1990s (next-generation sequencing- NGS), and currently utilizes third-generation sequencing technologies (TGS).

Structural Genomics

It aims at characterizing the structure of the genome. Structural genomics starts with the mapping of genes and markers to individual chromosomes and finally the preparation of a physical map by help of sequencing.

Tools of Structural Genomics

Genome Sequencing and Molecular markers:

a. Whole genome sequencing: The sequencing approach to know order of nucleotides in DNA was dramatically boosted by use of post-Sanger sequencing approaches based on Next Generation Sequencing (NGS) platforms (Wani, 2019). The most prominent NGS platforms (Figure 1) are Illumina Solexa, Qiagen Genereader, Roche 454, Life Technologies Ion Torrent semiconductor sequencing, Applied Biosystems (AB) SOLiD (Sequencing by Oligo Ligation Detection) Polony method and Complete Genomics.

The first four methods (Illumina Solexa, Qiagen Gene reader, Roche 454 and Life Technologies Ion Torrent semiconductor sequencing methods) use DNA synthesis for sequencing (sequencing by synthesis method- SBS), while the last two methods (AB SOLiD Polony and Complete Genomics methods) make use of oligonucleotide hybridization (sequencing by hybridization method- SBH) to the template followed by ligation to the growing chain. SBH method is also referred as Sequencing by ligation (SBL).

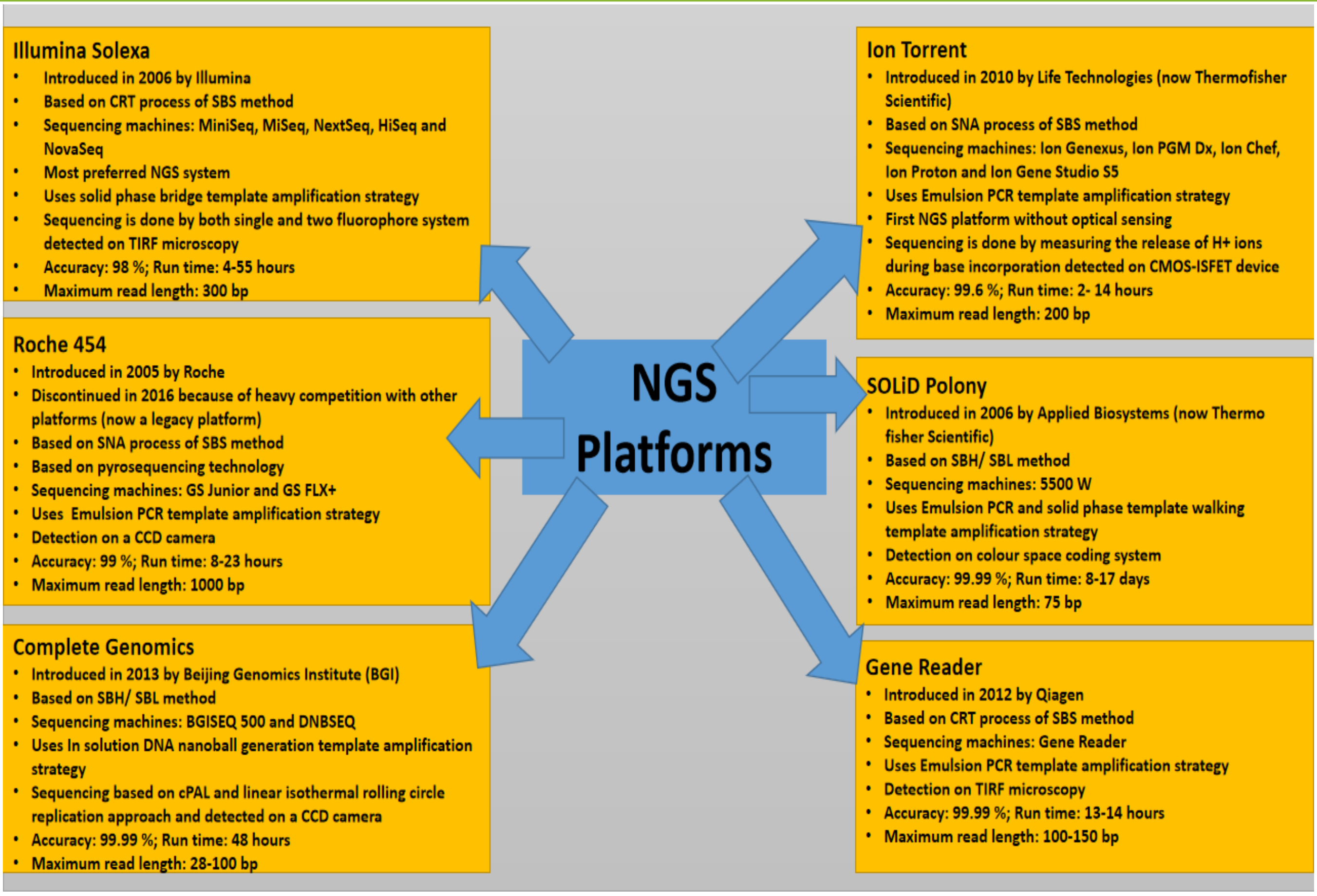

Figure 1: Features of different NGS platforms

The TGS methods are based on sequencing of single DNA molecules (single molecule sequencing-SMS) and they do not use PCR amplification for template preparation. The most widely used TGS technologies are Pacific Biosystems (PacBio) single molecule real-time (SMRT) sequencing (detection system is focused on DNA polymerase molecule; introduced in 2011; accuracy: >87%) and Oxford Nanopore (MinION/GridION/PromethION) (uses a synthetic cyclodextrin-based sensor; introduced in 2015; accuracy: >97%) generate long read length up to 100 kb and 1 Mb, respectively, with an average of 10–15 kb as against the usual average Illumina read length of 125–300 bp.

b. Molecular Markers: Genomics applications involving molecular markers are largely influenced by use of Single Nucleotide Polymorphisms (SNPs). The high abundance of SNPs in genomes (about one SNP every 100–300 bp of plant genomes) is particularly beneficial for their use in genomics. SNPs constitute ~90 % of the genetic variation in any organism. This marker system yields reliable and reproducible results.

Discovery of SNPs

1. Whole genome sequencing or EST sequencing: Technique involves sequencing of whole genomic DNA or cDNA (complementary or copy DNA) from two or more individuals/lines of a given species and comparing these sequences using a suitable computer program. SNPs may also be discovered by in silico alignment and analysis of genomic sequence or EST (Expressed Sequence Tags) sequence data available in the online databases. In case, a reference genome for the particular concerned species is not available, genome sequence of a related species or of the parental species may be used for sequence alignment and marker discovery.

2. Ampilcon sequencing: Technique in which a pair of specific primers is used for PCR amplification of the desired genomic region, and the PCR product (amplicon) is sequenced for detection of SNPs.

3. Transcriptome resequencing: This method avoids repetitive sequences of complex genome and also identifies SNPs within transcripts that may serve as functional markers.

Reduced Representation Sequencing

1. Genotyping by Sequencing (GBS) and its different subtypes: GBS being a type of Reduced Representation Sequencing (RRS) allows the reduction of genome complexity before sequencing, reducing per-sample costs and effort required for data analysis. In GBS, large number of SNPs are produced for genotyping and genetic analysis in several crop species. Complexity reduction can be performed involving single restriction enzyme digestion (1 enzyme GBS) or digestion of DNA with two different restriction enzymes (2 enzyme GBS).

Since the inception of GBS, it has undergone continuous development, giving rise to several approaches/subtypes based on RRS. These are Restriction site-associated DNA sequencing (RADseq), Double-digest RAD sequencing (ddRAD), Sequence-based genotyping (SBG), restriction enzyme site comparative analysis (RESCAN), Complexity reduction of polymorphic sequences (CRoPS). RADseq and ddRAD involve sequencing fragments to moderate coverage between 5x and 15x, but original GBS and two-enzyme GBS studies tend to reach low coverage of ~1x.

2. RNA-seq and exome-seq: These are RRS approaches, which allow more selective sequencing having focus only on protein-coding regions. RNA-Seq is accomplished by reverse transcribing RNA in vitro and sequencing the resulting cDNAs, which detects all transcripts in a sample, including the regulatory siRNA and lncRNA transcripts. An important advantage of RNA-seq is that it does not require any prior genomic information.

However, exome sequencing approaches rely on the availability of high-quality reference genomes with precise annotation. Exome sequencing does not allow analysis of gene expression levels, whereas it enables sequencing of unexpressed alleles and genes that cannot be done by RNA-seq. RNA-seq and exome sequencing does not need the use of restriction enzymes.

Functional Genomics

It is defined as the development and application of global or genome-wide experimental approaches to assess gene function and the interactions between genes in regulatory networks by using the information and components provided by structural genomics.

Tools of Functional Genomics

Sequencing-Based Approaches:

a. Serial Analysis of Gene Expression (SAGE): SAGE is an approach to quantitate the abundance of thousands of transcripts simultaneously in any particular cell or tissue, without prior knowledge of the genes. This method takes advantage of the 3′-portion of mRNA as the gene tag, but of much shorter form (9–10 bp) which are concatenated into a plasmid vector and sequenced in a single reaction, giving an absolute measure of gene expression by obtaining sequences of several dozens of mRNAs. SAGE procedure uses an anchoring enzyme which cleaves at every 256 bp generating sticky ends. The most commonly used anchoring enzyme is NlaIII which is 4 bp recognizing enzyme.

b. Massively Parallel Signature Sequencing (MPSS): MPSS is a tag-based approach, where longer sequence tags are ligated to microbeads and sequenced in parallel, enables analysis of millions of transcripts simultaneously. Due to longer tags and high-throughput analysis, MPSS can identify genes with greater specificity and sensitivity.

Hybridization-Based Approaches

1. SNP Array/ Microarray/DNA chips/ biochips: It is high-throughput, relatively cost-efficient, and automatic genotyping assay. It utilizes hybridization of the target DNA with fluorescent cDNA or oligonucleotide probes attached to a surface made up of silicon or nylon or glass to assess expression of multiple genes. The target DNA is either radioactively labelled or non-radioactively labelled (biotin or digoxigenin labelling). Two platforms are used for array-based genotyping: Illumina GoldenGate and Affymetrix Molecular Inversion Probe (MIP) Technology. There are some other platforms also like Illumina Infinium, Beckman Coulter GenomeLab SNPStream. The Affymetrix's MIP arrays and Beckman Coulter's GenomeLab SNPStream use chips prepared on glass, whereas Illumina's GoldenGate and Infifinium platforms use chips based on microbeads.

2. Tiling Microarray: This technique functions in a similar way like microarray but only difference is that it represents the gene expression profile of the entire genome at a very high resolution of a particular species for which the whole genome sequence is already available. Thus, a genomic tiling array identifies a greater number of SNP markers than a general microarray. Tiling arrays can be used to identify novel transcriptional units on chromosomes and can map methylation sites and alternative splice sites.

Comparative Genomics

The rapid rate at which genome sequence data is accumulated has given rise to an era of comparative genomics. With the help of comparative genomics differences and similarities in genome structure and organization in different organisms can be scanned and taken into account which will help in identifying new genes (Singh and Singh, 2015). There are many popular databases which makes the comparative genomics workflow very easy such as: National Centre for Biotechnology Information-NCBI, Plant Genome Database Japan- PGDJ, EnsemblPlants, Gramene, Plant GDB, TropGENEDB, Phytozome, Plant Genome Duplication Database, PTGBase, GreenPhylv5, PLAZA etc.

Epigenomics

A genome-wide study of the epigenetic marks/ epigentic modifications is referred to as epigenomics. An organism has multiple, cell type-specific, epigenomes comprising epigenetic marks such as DNA methylation, histone modification and nucleosome positioning.

Tools of Epigenomics

1. Whole-Genome Bisulfite Sequencing (WGBS): It is a high-throughput, genome-wide analysis of DNA methylation (Figure 2). The input DNA is first treated with sodium bisulfite, which converts (deamination reaction) unmethylated cytosines to uracil, whereas the methylated ones remain as cytosines. Bisulfite sequencing will read normal cytosine as thymine, while methylated cytosine will be read as cytosine. The resulting DNA is sequenced on an NGS platform, which usually produces a huge number of short reads.

2. Reduced-Representation Bisulfite Sequencing (RRBS): In the method of RRBS, an intitial step of digestion of DNA using a methylation- insensitive restriction enzyme is done with special target for CpG enriched fragments. This technique has got the advantage of sequencing no repeat sequences. After digestion and generation of fragmented DNA, it is treated with sodium bisulfite and sequenced on an NGS platform.

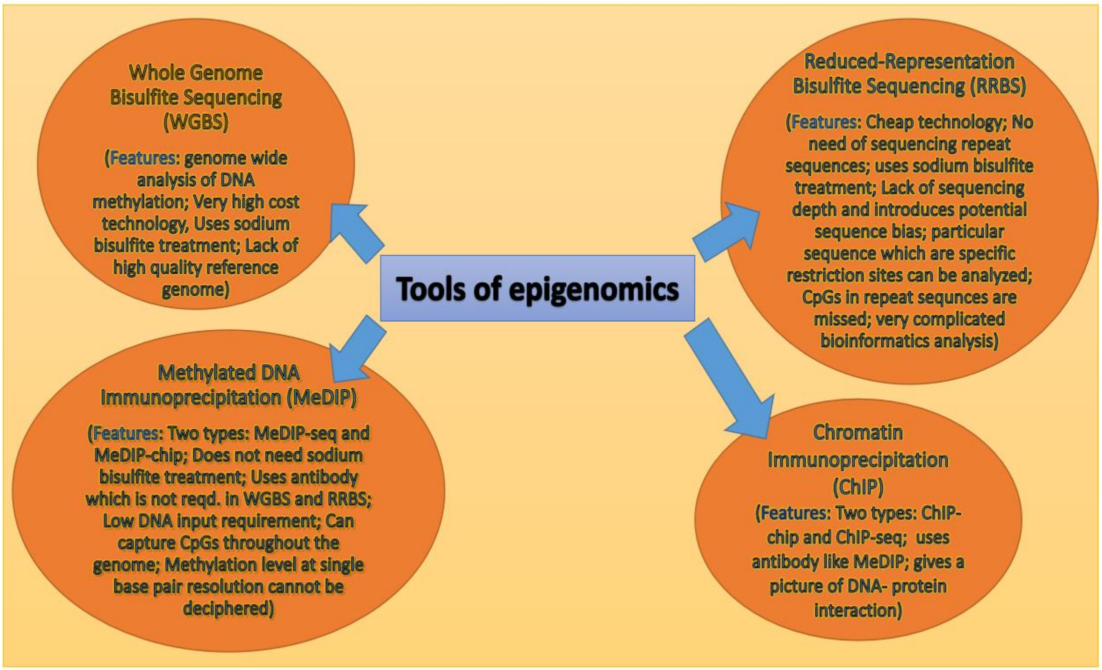

Figure 2: Tools of epigenomics

1. Methylated DNA Immunoprecipitation (MeDIP): In MeDIP, the input DNA is first sheared into fragments of varying lengths (between 300 and 600 bp) usually by sonication or digested with micrococcal nuclease (MNase), after which an immunoprecipitation step is done, where methylated fragments are isolated by using 5-methyl cytosine (5mC) monoclonal antibody (which are highly specific for their antigens—either 5mC- 5-methyl cytosine, or 5mCG- 5 methyl cytosine guanine, or 5hmC- 5 hydroxymethyl cytosine). The resulting DNA fragments can be either sequenced on an NGS platform (MeDIP-seq) or hybridized to a microarray (MeDIP-chip). MeDIP-seq generated reads can be aligned to a reference genome.

2. Chromatin Immunoprecipitation (ChIP): ChIP is a similar method like MeDIP which starts by shearing the DNA, either by sonication or enzyme digestion and the created fragments are immunoprecipitated using a specific antibody. The immunoprecipitated DNA is purified and hybridized with a tiling microarray (ChIP-chip) or sequenced on a NGS platform (ChIP-seq).

Metagenomics

It is the branch of science which deals with the study of the metagenome which is actually the collective genome of microorganisms from an environmental sample. A typical metagenomic analysis involves the isolation of metagenomic DNA from the environmental samples, followed by 16S rRNA gene amplification and shotgun metagenome sequencing, analysis of amplicon reads, analysis of metagenomic reads and finally the determination of microbial community diversity.

Transcriptomics

It is the branch of science which deals with the differential expression profile of transcriptome of an organism spatially and temporally during various developmental stages and under varying physiological conditions. Transcriptome includes all the transcripts present in a cell along with mRNA, miRNA, lncRNA and other small RNAs.

Tools of Transcriptomics

RNA-Seq and Microarray: Both the techniques are already discussed in the genomics portion of the chapter. Compared to microarrays, RNA-Seq can measure both low-abundance and high-abundance RNAs and importantly RNA-Seq requires much less starting material for start of experiment (nanograms vs. micrograms and even as little as 50 pg).

RNA sequential probing of target (RNA-SPOT): It is a technique which is accurate and a lowcost approach to sequence transcriptome in a cell based on Single-molecule Fluorescence in situ hybridization (smFISH) (Wani, 2019). Specific sets of genes can be selectively profiled with RNA SPOTs. In the process of RNA-SPOT, the transcripts are captured on coverslip containing locked nucleic acids (LNA) poly-dT and hybridized with a pool of thousand transcripts, and 12 pseudocolor schemes have been used for barcoding approximately 10,000 genes for hybridization. The fluorescence dyes used in the process are Cy3b, Alexa 594, and Alexa 647 which are repeated four times to iterate through all 12 schemes. Each dot detected in RNA-SPOT corresponds to a single mRNA.

Single-cell RNA-Seq (scRNA-Seq): This technique is based on the RNA seq but differs only in the transcriptome sequencing of individual cell rather than sequencing the bulk transcriptome. The process starts with isolation of single cells, capture their transcripts, and generating sequencing libraries in which the transcripts are mapped to individual cells.

Proteomics

It is the branch of science which deals with the study of proteome which is the complete set of proteins produced in a cell during a specific developmental stage and under the given environmental conditions. Proteomics studies help to elucidate the role of proteins in various regulatory processes.

Proteomics was started with the introduction of the two-dimensional gel protein electrophoresis (2DE). Later the most booming technology which emerged as the sole player in proteomics industry was the development of mass spectrometry (MS). In this technology, the mass and charge of small protein fragments are measured which results from protease digestion and generates a standard MS-spectra that is later interpreted to reveal the sequences of peptides and the occurred modification in protein samples.

Use of Bioinformatics Tools in Proteomics

There are multiple machines used in omics technologies including sequencers, arrays and mass spectrometers, which generates an ample amount of data. Hence, all these approaches need help of bioinformatics tools, online databases, platforms, packages and algorithms that help in analysis, integration, storage of omics data and also enable exchange of data among researchers. Examples of such resource portals for proteomics analysis are ExPASy (Expert Protein Analysis System) operated by the Swiss Institute of Bioinformatics (SIB), UniProt, Prosite, Conserved Domain Database, Swiss PDB Viewer, Rasmol that provides comprehensive, high quality and freely accessible resources for protein structure and functional information (Boopathi, 2020).

Conclusion

The combined approaches of genomics, transcriptomics, proteomics along with bioinformatics can help to elucidate the genome, transcriptome and proteome of an organism or a species which can help plant breeders utilize these resources for crop improvement and ultimately lead to sustainable agriculture. Use of omics tools in agriculture can provide potential health benefits to consumers, contribute to a stable food and energy supply, help preserve and protect the environment, benefit farmers, and help eliminate world hunger. The use of omics technologies is a booming industry in the field of agriculture and is always committed to the development and betterment of mankind.

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Technologies For Production of Biochar Using Biomass

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Shruti Thaneer[1], Prakash K. V[1], Sunil Shirwal[1], Sushilendra[1], Mareppa H[1]
[1]Department of Farm Machinery and Power Engineering, College of Agricultural Engineering, University of Agricultural Sciences, Raichur (Karnataka), India.

Introduction

The energy demand in the world is increasing as the population of world is increasing. Improper disposal of biomass produced by the agricultural sector is a major challenge worldwide. Increasing energy demands and waste management concerns have motivated agricultural producers to consider the decentralized conversion of agricultural by-products for energy and value-added product (biochar). Biomass is considered to have potential to be used as an alternative energy source. Biomass is a promising, eco-friendly, and renewable source for generating energy, fuels and chemicals that could partially replace fossil fuels to reduce the pressure of environmental pollution problems. The utilization of biomass for biochar production could offer a solution to the existing issues. Biochar production through pyrolysis, temperature should be more than 300˚C and Biochar production technologies are grouped into two approaches, traditional approaches and modern approaches.

Traditional Approaches

1. Early approach:

a. Biomass is burnt in a space which is open and covered with half burned biomass with soil immediately. (Thines *et al.*, 2017).

b. Handmade reactors such as clay burners, iron retorts, clay burners and firebrick pits.

Application: Soil amendment.

2. Slow pyrolysis:

a. Slow pyrolysis, also called as conventional pyrolysis, where biomass is heated at temperature in the range of 300–600 °C with a heating rate of 5–7 °C min^{-1}.

b. Slow pyrolysis yields biochar as a major product (35–45%) along with other products as bio-oil (25–35%) and syngas (20– 30%) (Lai *et al.*, 2003).

Applications: Soil amendment, Bio-oil, Syngas as an energy fuel.

3. Fast pyrolysis:

a. For production of biochar, temperature should be above 500 °C with a heating rate of more than 300 °C min^{-1} in the absence of oxygen.

b. The product yield of fast pyrolysis is reported as 60% bio-oil, 20% biochar and 20% syngas. (Dai *et al.*, 2017).

Applications: Adsorbent, Soil amendment.

Modern Approaches

1. Gasification:

a. Gasification is an effective thermochemical conversion process for biomass into energy fuel while producing biochar as a by-product with temperature > 700 °C with gasifying agents.

b. Gasification is a common technique for producing syngas from different solid fuel resources (Al -Rahbi and Williams 2017).

Application: Dye removal from wastewater, adsorption of chemicals, carbon sequestration, and as a soil amendment agent.

2. Torrefaction: Burning of the biomass at relatively low temperatures (230 and 300 °C) and improves the properties of biomass (Bourgeois and Doat, 1984).

Application: For improving the physical, chemical, and biochemical characteristics of raw biomass.

3. Flash pyrolysis:

a. Flash pyrolysis is an improved and modified form of fast pyrolysis.

b. Flash pyrolysis is operated at temperatures ranging from 900 to 1200 °C, which can be attained within a second (Li *et al.*, 2013).

Application: Soil amendment, Bio-Oil, Syngas.

4. Vaccum pyrolysis:

a. Vacuum pyrolysis is a thermal degradation of biomass under vacuum or low pressure in the absence of oxygen.

b. Pressure and temperature range during the vacuum pyrolysis are controlled between 0.05 and 0.20 MPa and 450–600 °C, respectively (Tripathi *et al.*, 2016).

Application: High porosity biochar, Adsorption of mineral, Soil amendment.

5. Hydrothermal carbonization: In the HTC method, there is no need to dry the biomass before processing, where the wet biomass mixture is heated up to temperatures ranging 220–240 °C under high pressure (2–10 MPa) reactor for several hours (Hu *et al.*, 2010)

Application: Retention of nutrients, High calorific value, Better grindability, Improved hydrophobicity.

6. Microwave pyrolysis:

a. In microwave pyrolysis the temperature for biochar production is 450 °C, 400 W microwave power, and 4–6 min resident time (Hossain *et al.*, 2017).

b. Biochar production through microwave heating is a prominent advanced technique.

Application: Soil amendment, Bio-Oil, Syngas.

Conclusion

Increase in waste like municipal waste, sea waste, industrial waste etc with increase in population, industrialization and urbanisation have resulted in air, water and soil pollution due to burning and dumping of theses waste in landfills. Technologies for biochar production from biomass are modernized continuously for improving the quality and production rate and also to reduce emission of greenhouse gases and helps in the reduction of global warming.

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Effect of Rhizosphere and Factor Influencing their Growth and Activities

Article ID: 35060

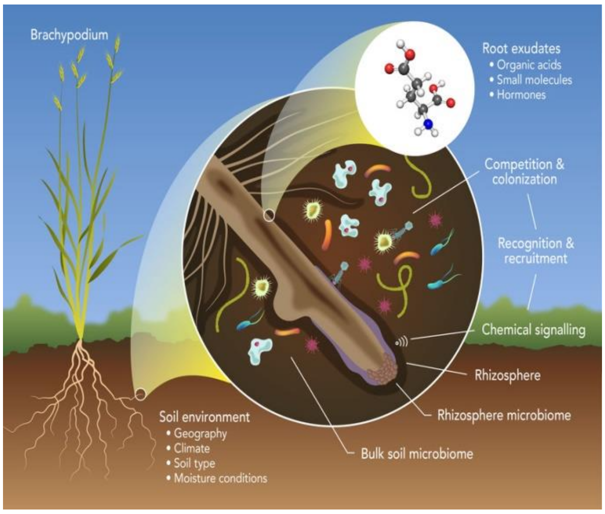
Ravi Regar[1], Anand Kumar Meena[2]
[1]PhD. Scholar, Department of Plant Pathology, S.K.N. College of agriculture, Jobner, Jaipur.
[2]Assistant Professor, Department of Plant Pathology, SKNAU, Jobner, Jaipur.

Introduction

In 1904 the German agronomist and plant physiologist Lorenz Hiltner first coined the term "rhizosphere" to describe the plant-root interface, a word originating in part from the Greek word "rhiza", meaning root (Hiltner, 1904; Hartmann et al., 2008). The rhizosphere is the area around the plant root that is influence by several factors like the root exudates and soil microorganism. It is the most active region of the soil present around the root. It is fluctuating with the growth of plant root. It is an important part of soil microbiology which is responsible for various metabolic processes occurring in the soil like cycling of nutrients and uptake of carbon. The roots release various compound like root exudates that support higher microbial populations so rhizosphere extends a few millimeters from the root surface. Also, important function as in rhizosphere zone many microorganisms present which are effective agents' harmful microorganism to suppress their growth.

Effect of Rhizosphere

1. During seed germination and seedling growth, the developing plant interacts with a range of microorganisms present in the surrounding soil. As seeds germinate and roots grow through the soil, the release of organic material provides the driving force for the development of active microbial populations in a zone that includes plant root and surrounding soil in a few mm of thickness. This phenomenon is referred as the rhizosphere effect (Morgan et al., 2001).
2. Influence of plant root due to microbial activities.
3. The rhizosphere effect on soil microbial population.
4. The rhizosphere effect is higher for bacteria > fungi > actinomycetes > protozoa.
5. The microorganism diversity is higher near to the rhizoplane.
6. The interaction between plant nutrients in soil and plant exudates changes the microclimate of the rhizosphere.
7. The rhizosphere effect is a result of the interaction between the plant root and the microbial community of the region.



Microorganism Found in Rhizosphere

1. Microorganism like bacteria, fungi, parasites, viruses, and algae present in rhizosphere.

2. Rhizosphere microbiome means microbial population in the rhizosphere.
3. In rhizosphere the populations of the microorganisms are different from the rest of the soil.
4. Bacteria in the rhizosphere are larger and have higher proportions of Gram-negative bacteria than those in the bulk soil.
5. Some of the examples of microorganism like *Bacillus*, *Arthrobacter*, *Pseudomonas*, *Agrobacterium*, *Xanthomonas*, *Tricholoma*, *Verticillium*, *Rhizoctonia*, *Actinomadura*, etc. (Figure 1).

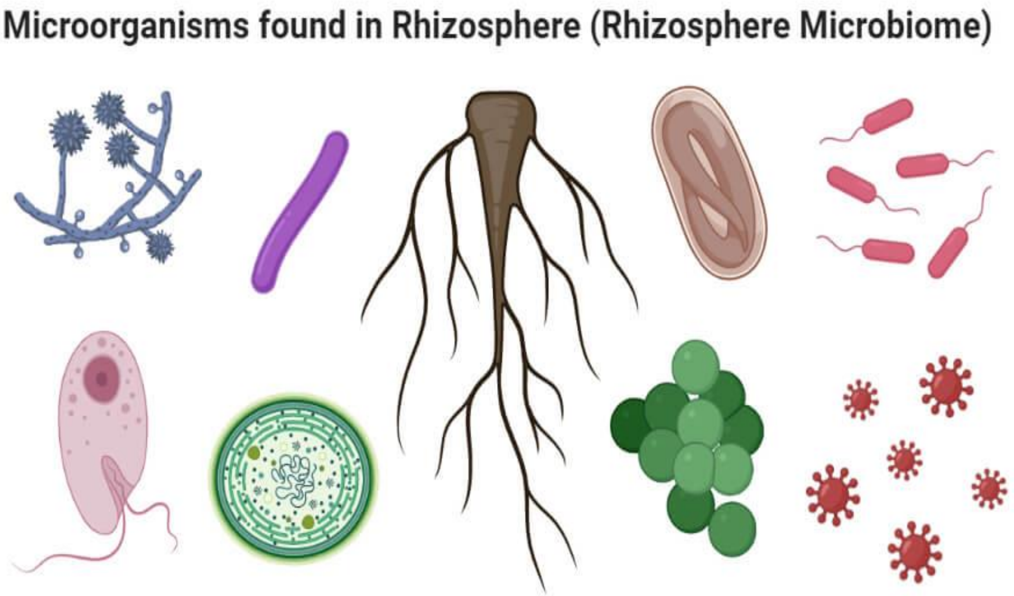


Figure 1: Microorganisms found in Rhizosphere

Factor Influencing Rhizosphere Growth and Activities

1. Nutrients
2. Physiological factors of soil:
    a. Soil pH.
    b. Soil temperature.
    c. Soil moisture.
    d. Soil atmosphere.
    e. Soil type.
3. Interactions.

Nutrients

Mostly they are chemoorganoheterotrophic. Use organic compounds as carbon and energy sources. In the rhizospheric area, other forms of nutrients are released by the plant in the form of root secretions and root exudates. Availability of nutrients increase the microorganism population.

Physiological Factors of Soil

1. Soil ph - If the activity and population of the rhizosphere microflora is more, then the PH of rhizosphere region is lower than that of surrounding soil.
2. Soil moisture – Microorganisms are more when soil moisture is low.
3. Soil type – Rhizosphere effect is more in sandy soil.
4. Soil temperature - affects the physical, chemical, and biological processes in the soil.

Interaction

Different soil organisms frequently interact with each other. Three types of interaction positive, negative, or neutral.
1. Positive interactions - enhance the abilities of populations to survive within a particular habitat.
    a. Commensalism.
    b. Synergism.

c. Mutualism.

2. Negative interactions - limit the population growth.
   a. Competition.
   b. Amensalism.
   c. Predation/ parasitism.

3. Interactions like symbiosis and mycorrhiza favor the growth of organisms and their activities in the soil.

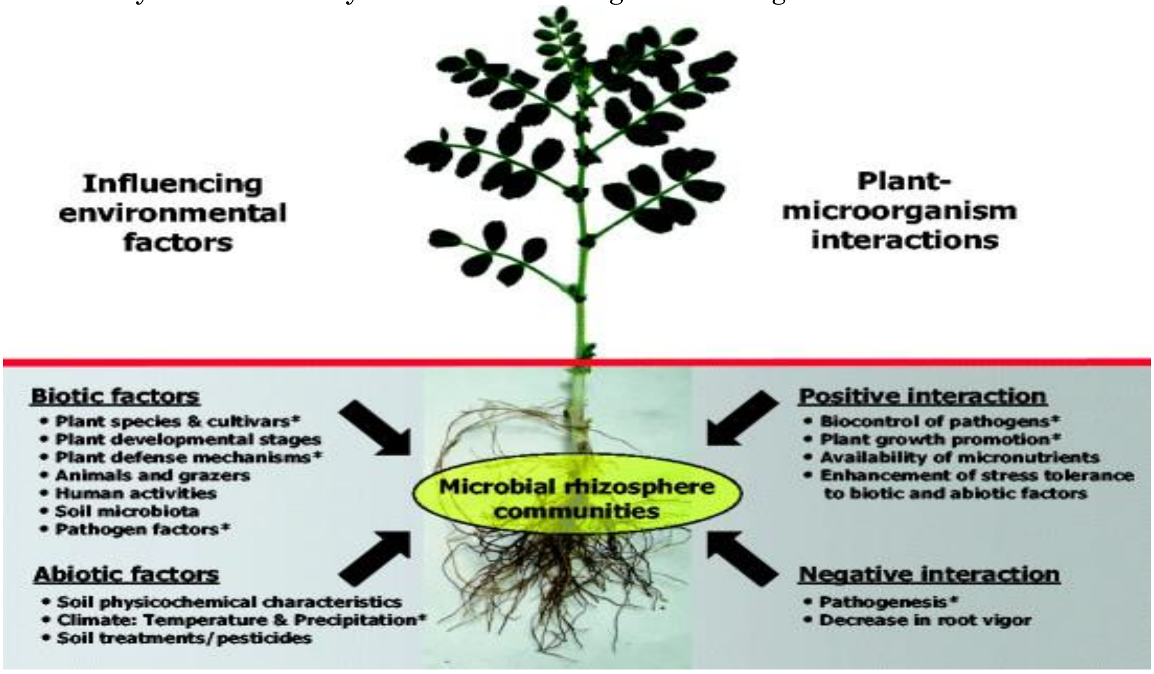


Figure 2 Factor influencing rhizosphere growth and activities

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Chitinolytic Bacteria as Biocontrol Agents

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Sankari Meena K[1], Deepa S. P[2], Manju P[3], Vijayakumar S.[1]
[1]ICAR-Indian Institute of Oilseeds Research, Rajendranagar, Hyderabad, Telangana.
[2]J. K. K. Munirajah College of Agricultural Science, Erode, Tamil Nadu.
[3]Kumaraguru Institute of Agriculture, Erode, Tamil Nadu.

Introduction

Crops are more sensitive to the infestation of insects and pathogenic fungi. Alternatives to chemical pesticides are essential to eradicate the illness in an ecofriendly way. Chitinolytic bacteria have shown potential as biocontrol agents for a variety of crops. This chapter discusses the various forms of chitinases, as well as their occurrence in various species such as bacteria and fungus, as well as their impact on pests and diseases.

Role of Chitinase in the Control of Pests and Diseases

Chitin is one of the most common biopolymers found on the earth. Crustaceans and insects have it in their shells, exoskeletons, and gut linings. It is also found in the cell walls of many fungi and it give the structural framework to nematode eggs. Chitin and cellulose are structurally and functionally identical. Chitin is made up of (1, 4)-linked N-acetyl-D-glucosamine residues, whereas cellulose is made up of glucose monomers.

Chitin exist in three crystalline forms α, β and ϒ chitin, which differs in the arrangement of polymer chains, giving them different mechanical properties (Jang *et al*., 2004). The different chains cross link to other structural polymers such as proteins, β glucans to provide rigidity and strength. In environment, chitin is found in full acetylated form to its completely deacetylated form. Chitosans are chitins that have been deacetylated.

Hydrolytic enzymes are produced in abundance by microorganisms. Chitinase are among the most important hydrolytic enzymes. These chitinases weaken or degrade the cell walls of many pests and pathogens thereby exhibiting insecticidal, antifungal and nematicidal properties (Stoykov *et al.,* 2015). Chitinases catalyse the degradation of chitin. These enzymes have been found in viruses, bacteria, archaea, Protista, higher plants, and mammals and could be exploited in biocontrol programmes. Researchers have called for the development of alternative pest and disease control methods using chitinolytic bacteria in response to alarming outcomes found with the use of conventional pesticides and fungicides.

Streptomyces, *Bacillus*, and *Pseudomonas* species are among the most common bacteria utilized as biocontrol agents. Despite the well documented negative impacts of pesticides on the environment, the idea of developing new insecticides including biocontrol bacteria could be a viable remedy. Chitinases damage the peritrophic membranes that line the gut epithelium of insect larvae when they come into contact with them. Chitin is the principal component of these membranes in insects. The douglas-fir-tussock moth, *Orgyia pseudotsugata* peritrophic membrane was degraded by chitinases and later this effect was observed in *Spodoptera littoralis* and *Escherichia coli* that expressed the endochitinases chi A II from *Serratia marescens*.

Actinobacteria

They are among the most important taxa in the chitinolytic community of soil microbes (Franco *et al*., 2003). A number of chitinases have been identified in Actinobacteria. *Streptomyces coelicolor* were found to produce 13 different chitinases, 11 different GH18 types (A, B and C) and 2 different GH 19 types. In the presence of chitin, *Nocardiopsis prasina* secretes 3 chitinases namely, Chi A, Chi B and chi BΔ (Tsujibo *et al*., 2003). Antifungal activity was high in GH 19 type chitinases. Gherbawy *et al.* (2012) recorded those seven strains producing GH 19 chitinases had antifungal activities against F. *oxysporum, Pythium aristosporum, Colletotrichum gossypii* and *Rhizoctonia solani*. GH 18 chitinases of *Streptomyces roseolus* exhibited an inhibiting effect on fungal hyphal expansion (Xiayun *et al.,* 2012). In terms of chitinase activity, *Streptomyces* is one of the most studied genera. Many additional actinobacteria, albeit less well investigated, have comparable properties.

Table 1. Bacterial chitinases in the biocontrol of pests and diseases:

S. No.	Biocontrol agent	Pathogens controlled	In vitro / in vivo	Biocontrol attributes	References
1.	*Streptomuces rimosus*	*Fusarium solani; Alternaria alternata*	In vitro	Chitinase	Brzezinska et al., 2013
2.	*S. viridificans*	*Rhizoctonia, Colletotrichum, Aspergillus, Fusarium, Sclerotinia, Curvularia* and *Pythium.*	In vitro	Chitinase	Gupta et al.,1995
3.	*S. hygroscopicus*	*Colletotrichum gleosporioides* and *Sclerotium rolfsii*	In vitro	Chitinase	Prapagdee et al., 2008
4.	*S. cavourensis*	Pepper - Anthracnose	In vivo	Chitinase, 2-furancarboxaldehyde	Lee et al., 2012
5.	*B. thuringiensis*	*Verticillium* spp.	In vivo	Chitinase	Hollensteineret al., 2017
6.	*B. pumilis*	Several genera of pathogenic fungi and *Scirpophaga incertulas*	in vitro	Chitinase	Rishad et al., 2016
7.	*Paenibacillus illinoisensis*	Root knot nematode	In vitro	Chitinase	Jung et al., 2002
8.	*Paenibacillus* sp.	*Helicoverpa armigera*	In vitro	Chitinase	Singh et al.,2016
9.	*Serratia marescens*	*Botrytis cinerea*	In vitro	Endochitinase and chitobiase	Someya et al., 2001
10.	*Enterobacter* spp.	Colletotrichum gloeosporioides	In vitro	chitinase	Suryanto et al., 2014
11.	*Stenotrophomonas* and *Chromobacterium*	*Globoderarostochiensis* eggs	In vitro	chitinase	Cronin et al.,1997
12.	*Pseudomonas* spp.	Spodoptera litura larvae	In vitro	chitinase	Zhong et al.,2015
Post-harvest diseases					
13.	*Bacillus subtilis*	*Fusarium oxysporum* and *Botryodiplodia theobromae*	Yam	chitinase	Swain et al., 2008
14.	*B. subtilis* (J9)	*B. cinerea*	Strawberry	chitinase	Essghaier et al., 2012
15.	*B. cereus*	*Rhizopus stolonifer*	Peach	chitinase	Wang et al.,2013.

Actinomycetes isolates with chitinase activities were shown to have fungicidal effects in *in vitro* experiments, while isolates that did not produce chitinase only had a fungistatic effect (Tahtamouni *et al.*, 2006).

Firmicutes

Chitinase expression has been found in *B. thuringiensis*, a strong insect biocontrol agent (Liu *et al.*, 2010).

Kramer and Muthukrishnan (1997) recorded synergistic effect between *B. thuringiensis* endotoxins and chitinases. In these situations, combined formulations containing bacterial consortia will be more efficient than single *B. thiringiensis* strains.

B. thiringiensis derived chitinases enhanced the insecticidal activity of crystal protein against larvae of *Spodoptera exigua* and *Helicoverpa armigera* and almost entirely hindered the germination of *R. solani* and *B. cinerea* spores, according to studies of Liu *et al.* (2009). The bacteria *Paenibacillus* sp. was discovered to be compatible with pesticides, and when combined with the pesticide acephate, they had a synergistic impact in controlling lepidopteran insects.

Proteobacteria

ChiA, ChiB, ChiC1, and ChiC2 are among the GH18 chitinases produced by *Serrabia marescens.* These enzymes are more effective at hydrolyzing chitin.

Conclusion

Several studies have shown that chitinolytic bacteria can be used to combat pests and diseases. Bioagents comprising different metabolites, including chitinases, tend to be more effective than purified chitinolytic enzymes against pests and diseases. Hence, use of bioagents including a consortium of chitinolytic bacteria appears to produce superior results in fighting against agricultural pests and diseases.

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Export Quality Management in Banana

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Sathish B. R[1]., Kiran Sagar D. C[2]
[1]Department of fruit science, College of Horticulture, Bagalkot- UHS, Bagalkot.
[2]Department of fruit science, College of Horticulture- Bengaluru, UHS, Bagalkot.

Banana (*Musa paradisica* L.) belongs to the family Musaceae and genus *Musa,* a plant genus of extraordinary socio-economic significance to mankind. The name banana comes from the Arabic word 'BANANA', which means finger. It is also known by other synonyms like 'Adam's fig,' 'Kalpataru,' 'Tree of wisdom' and 'Apple of Paradise.' It is one of the oldest fruit crops known to mankind. Banana is the leading fruit crop in tropical and subtropical regions of the world. It ranked second after mango in area and production and grown in more than 132 countries of the world. The fruit is recognized as the fourth most important global food commodity in terms of gross value exceeded only by paddy, wheat and maize. It is the staple food of many countries and can be utilized for fodder and fiber too.

Varieties Suitable for Export

1. Grand Naine (AAA): It produces a bunch weighing 25 kg and may go up to 32-35 kg with 8-10 hands with 200-220 fruits/bunch.

2. Robusta (AAA): It is a high yielding and produces bunch of large size with well-developed fruits. Fruit is very sweet with a good aroma. Bunch weighs about 25-30 kg. It having 8-10 hands/bunch. The length is 15-20 cm.

3. Red Banana (AAA: Its commercial cultivation is prominent in Kanyakumari and Tirunelveli districts of TN while in Karnataka called as Chandra Bale. It is a robust plant with bunches weighing 20-30 kg under good management practices.

4. Nendran (AAB): It is a popular variety in Kerala where it is relished as a fruit as well as used for processing. Commercial cultivation of Nendran has picked up rapidly in Tamil Nadu in the recent past. Bunch has 5-6 hands weighing about 12-15 kg.

5. Dwarf Cavendish (AAA): It is a popular commercial cultivar grown extensively for table and processing purpose in the states Maharashtra, Gujarat, Bihar and West Bengal. The plant is dwarf with large bunches weighing about 20 kg. It's compactly arranged 8-10 hands and length is 13-14 cm.

Minimum Requirements

In all classes, subject to the special provisions for each class and the tolerances allowed, the banana must be:

1. Whole (finger as the reference).
2. Firm, sound, produce affected by rotting or deterioration such as to make it unfit for consumption is excluded.
3. Clean, practically free of any visible foreign matter.
4. Practically free of damage caused by low and/or high temperature.
5. Practically free of pests affecting the general appearance of the produce.
6. Practically free of damage caused by pests.
7. Free of abnormal external moisture.
8. Free of any foreign smell and/or taste.
9. Practically free of bruises and blemishes.

Export Classes of Banana

Extra class - Bananas shall be of superior quality. They must be characteristics of the variety and/or commercial type. The fingers must be free of defects, with the exception of very slight superficial defects, provided these do not affect the general appearance of the produce, quality, the keeping quality and presentation in the package.

Class I - Bananas shall be of good quality. They must be characteristics of the variety and/or commercial type. The following slight defects of the fingers, however, may be allowed, provided these do not affect the general appearance of the produce, quality, the keeping quality and presentation in the package. slight defects in shape and colour, slight defects due to rubbing and other superficial defects not exceeding 2 sq.cm. of the total surface area. The defects must not affect the flesh of the fruit.

Class II - This includes bananas which do not qualify for inclusion in the higher classes, but satisfy the minimum requirements. The following defects may be there, provided the bananas retain their essential characteristics as regards the quality, the keeping quality and presentation. Defects in shape and colour provided the product remains the normal characteristics of bananas, skin defects due to scrapping, scabs, rubbing, blemishes or other causes not exceeding 4 sq.cm. of the total surface area are also included in this class.

Provisions Concerning Sizing

Size is determined either by length or diameter. The length is measured based on the middle finger in the outer row from the blossom end to the base of the pedicel where the edible flesh ends and maximum diameter of the equatorial section of the fruit, in accordance with the following table.

The reference fruit for measurement of the length and grade is:

a. For hands, the median finger on the outer row of the hand.
b. For clusters, the finger next to the cut section of the hand, on the outer row of the cluster.

For Large-Sized Varieties

Size Code	Length of fingers (milli meters)	Diameter (milli meters)
1	>200	>40
2	181-200	36-40
3	161-180	33-35
4	141-160	29-32
5	120-140	25-28

For Medium-Sized Varieties

Size Code	Length of fingers (milli meters)	Diameter (milli meters)
1	>110	>30
2	92-110	28-30
3	71-90	25-27
4	50-70	22-24

Provisions Concerning Presentation

Uniformity: The contents of each package must be uniform and contain only banana of the same origin, variety and/or commercial variety, type, quality and size. The visible part of the contents of the package must be representative of the entire contents.

Packaging: Banana must be packed in such a way as to protect the produce properly. The materials used inside the package must be clean and of good quality such as to avoid causing any external or internal damage to the produce. The use of materials, particularly of paper or stamps bearing trade specifications is allowed, provided the printing or labelling has been done with non-toxic ink or glue. Banana shall be packed in each container in compliance with the Recommended International Code of Practice for Packaging and Transport of Fresh Fruits and Vegetables (CAC/RCP 44-1995, Amd. 1-2004).

Description of Containers: The containers shall meet the quality, hygiene, ventilation and resistance characteristics to ensure suitable handling, shipping and preserving of the banana. Packages must be practically free of all foreign matter and smell.

Marking or labelling: Consumer packages -In addition to the requirements of the Codex General Standard for the Labelling of Pre- packaged Foods (CODEX STAN 1-1985, Rev. 1-1991), the following specific provisions apply.

Nature of Produce - If the produce is not visible from the outside, each package should be labelled as to the name of the produce and may be labelled as to name of the variety.

Origin of Produce - Country of origin and, optionally, district was grown or national, regional or local place name.

Packaging Details

1. For Export: For export purpose bananas are packed in telescopic type of corrugated fibre board boxes with good ventilated holes:

a. Top = 48.25cm X 31.75cm X 20.25cm -5 ply.
b. Bottom= 47.50 X 31.25cm X 19.75cm -5ply.
c. Gap plate= 3 ply.
d. Foam sheet or foam pad= 20mm thick, 38cm X 25cm size with 10 mm holes.
e. Weight of final packed box is approximately 13.0 Kg.

2. For Domestic Market: Bananas are transported as full bunches in trucks and are ripened at the destination and then cut into hands and transported in plastic crates.

Contaminants

Pesticide residues: Banana shall comply with those maximum residue limits established by the Codex Alimentarius Commission and/or by authority for this commodity.

Other contaminants: Banana shall comply with those maximum levels for contaminants established by the Codex Alimentarius Commission and/or by authority for this commodity.

Conclusion

Banana is the important fruit crop of the world and consumed by the whole group of peoples. Even though India is the second largest producer of fruits in the world our export potential is still limited due to improper post-harvest handling measures which in turn leads to deteriotion of quality thereby reduces the demand in the international market. The export potential of the banana can be improved by the selection of variety which is having good demand in the international market, Proper crop management to achieve finger size and bunch weight of international standards, harvesting at proper maturity stage, avoiding mechanical damages during harvesting and transporting, proper packaging and presentations are also required to improve the export potential of Bananas.

Insecticide Resistance in BPH: An Overview

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K Chandrakumara[1], Arunkumara C G[2]
[1]Ph. D Scholar, Division of Entomology, IARI, New Delhi.
[2]Department of Agricultural Entomology, UAS, GKVK, Bengaluru.

Introduction

The brown planthopper (BPH) *Nilaparvata lugens* (Stål) (Hemiptera: Delphacidae) is a notorious pest of rice crop throughout Asia (Cheng, 2009) including India, where it causes damage by directly feeding on the phloem of the stem, ovipositing into the stem and transmitting viral diseases (rice ragged stunt virus and rice grassy stunt virus) (Wang *et al.*, 2009).

It is monophagous pest, meaning feeds only on rice crop. Damage can be spotted by the presence of hopper burn symptom in the field. Due to its high fecundity, shirt life cycle and invasive capacity control depends on many insecticides. The large scale and intensive use of insecticides lead to high levels of resistance development by the pest to many of these major classes of insecticides.

In 2003, resistance against neonicotinoids (mainly imidacloprid) in BPH was first observed in Thailand (Harris 2006). BPH has developed resistance to more than 29 compounds in the world. It includes organophosphates, carbamates, pyrethroids, neonicotinoids, insect growth regulators and phenyl pyrazoles.

The various groups of insecticides recommended and against for which it shows resistance are listed in Table 1 and 2.

Table 1: Resistance to different groups of insecticides:

IRAC MoA Group	Insecticide Chemistry	MoA	BPH shows resistance
Group 1: Acetylcholinesterase (AChE) inhibitors	Carbamates	1A	√
	OP	1B	√
Group 2: GABA-gated chloride channel blockers	Cyclodiene and OC	2A	√
	Phenylpyrazoles (Fiproles)	2B	√
Group 3: Sodium channel modulators	Pyrethroids	3A	√
Group 4: Nicotinic acetylcholine receptor (nAChR) competitive modulators	Neonicotinoids	4A	√
	Sulfoximines	4C	√
	Mesoionics	4E	
Group 9: Chordotonal organ TRPV channel modulators	Pyridine azomethine derivatives	9B	
Group 16: Inhibitors of chitin biosynthesis, type 1	Buprofezin	16	√
Group 28: Ryanodine receptor modulators	Diamides (cyantraniliprole)	28	
Group 29: Chordotonal organ modulators – undefined target site	Flonicamid	29	

Note: √ indicates presence of resistance **(Source: IRAC**).

Table 2: Insecticides for which BPH shows resistance:

Sl. No.	Chemical group	Insecticides for which BPH showing resistance
1	Organophosphates	Chlorpyrifos, dinotefuran, monocrotophos
2	Carbamates	Malathion, fenitrothion, carbaryl, fenobucarb and isoprocarb
3	Pyrethroids	Etofenprox, permethrin, phenothrin
4	Neonicotinoids	Imidacloprid, thiamethoxam, clothianidin, nitenpyram
5	Insect growth regulators	Buprofezin
6	Phenyl pyrazoles	Fipronil, Ethiprole

7	Sulfoximine compounds	Sulfoxaflor

BPH has evolved different mechanisms to overcome the resistance. There are three enzymes (Esterase, carboxylase and glutathione S- transferase) which are mainly conferred to resistance. Variation in the expression of genes also impart the resistance to insecticides (Table 3).

Table 3: Mechanism involved in different insecticide resistance: (Source: IRAC):

Sl. No.	Chemical group	Mechanism involved in resistance
1	Organophosphates	Altered AChE (metabolic)
2	Carbamates	Altered AChE (metabolic)
3	Pyrethroids	Cytochrome P450 mono-oxygenases (metabolic)
4	Neonicotinoids	Cytochrome P450 mono-oxygenases (metabolic) + Over expression of genes
5	IGR (Buprofezin)	Metabolic
6	Phenyl pyrazoles	Metabolic + A301S mutation in the RDL GABA-gated chloride channel

Confirming the Resistance in BPH Against Various Chemicals

Under laboratory condition resistance can be estimated by three means *viz.*, bioassay, biochemical study (enzyme assay) and molecular study (gene expression analysis).

Zhang and his coworkers determined the susceptibility of twenty-one populations of *N. lugens* to eleven insecticides from 2012 to 2014 in eight provinces of China and results were expressed in terms of resistance ratio and enzyme expression (Table 4 and 5).

A study conducted by Bao and his workers (2016) revealed the contribution of two P450 monooxygenase genes, *CYP6AY1* and *CYP6ER1* towards resistance development against imidacloprid (due to over expression of genes).

Table 4: Resistance level of insecticides tested:

Sl. No.	Insecticides	RR Level/ RR Range	Category
1	Imidacloprid	233.3-2029	High resistance levels
2	Buprofezin	147.0-1222	
3	Ethiprole	11.5-71.8	Moderate resistance levels
4	Isoprocarb	17.1-70.2	
5	Thiamethoxam	25.9-96.9	
6	Clothianidin	6.1-33.6	Low moderate levels
7	Dinotefuran	6.4-29.1	
8	Chlorpyrifos	7.4-30.7	
9	Acetamiprid	2.7-26.2	Susceptible to moderate
10	Thiacloprid	2.9-8.2	Susceptible to low
11	Etofenprox	1.1-4.9	Susceptible

Table 5: Variation in the activity of different enzymes across the population tested:

Sl. No.	Enzyme	Activity (µmol/min/mg Protein) range	Fold variation
1	Esterase	1.69 ± 0.07- 3.65 ± 0.20	2.16
2	Glutathione s-transferase	6.72 ± 0.15- 8.74 ± 0.60	1.30
3	Cytochrome-p450-dependent monooxygenase	0.52 ± 0.03- 0.92 ± 0.13	1.77

Conclusion

Even though BPH showing resistance to many insecticides, it can be managed by different ways like rotation of insecticides with different modes of action, use of effective and specific insecticides rather than broad spectrum insecticides, always follow insecticide label instructions for application timings, volumes and concentrations, *etc.*

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True Weevils: An Overview of their Economic Significance

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K Chandrakumara[1]
[1]Ph. D Scholar, Division of Entomology, IARI, New Delhi.

Introduction

True weevils, including bark beetles (Scolytinae, formerly its own family) and pinhole borers (Platypodinae, formerly its own family), represent one of the largest families (Curculionidae) of organisms on the planet, with over 40,000 described species. One of the largest families in coleopteran comprising of more than 3,000 species of 500 genera. Members of this family are generally called as weevils or snout beetles. Adult lengths ranging from 1 to 40 mm (0.04 to 1.57 in). They show considerable variation in size, shape, and the form of the snout. The snout is fairly well developed in most species, with the antennae arising about the middle of the snout. In some of the nut weevils the snout is long and slender, as long as the body or longer. The most recent classification system to family level was provided by Kuschel. He classified into two groups: Primitive weevils (Anthribidae, Attelabidae, Belidae, Brentidae, Caridae, and Nemonychidae) and True weevils (Curculionidae).

Important Subfamilies of Curculionidae and their Features

Subfamily	General feature/ description of the subfamily
Baridinae	This is the largest subfamily of the Curculionidae, these beetles are small and stout-bodied.
Cyclominae	Most members of this group breed in aquatic or sub aquatic plants, and the adults are found near water.
Curculioninae	This subfamily is a large assemblage of taxa of questionable relationships. It includes the tribes Curculionini, Anthonomini, Gymnetrini, Otidocephalini, Rhamphini, and Tychiini.
Cossoninae	These can be usually recognized by the broad, short beak and the long, curved spine at the apex of each front tibia.
Entiminae	These are commonly called as "broad nosed weevils," because the snout is generally short and broad.
Molytinae	Most members of the Molytinae are dark-colored and of moderate size. Several species (especially species of Hylobius) are important pests of pine and other conifers.
Scolytinae	These are commonly called as 'bark beetles' and are distinct in their morphology due to their small size and cylindrical shape.
Platypodinae	These are commonly called as 'pin hole borers'. They are important early decomposers of dead woody plant material in wet tropics

Economic Importance of Weevils

Members of this family are diverse in their habit and habitat and have immense economic importance. Many are responsible for yield loss as they are pests of important agricultural and horticultural crops. Some other are weed killers, some are major pollinator, some members in association with fungi cause serious disease.

1. As serious pests of crops: They are the most important group of pests in the world, likely due to their great diversity and wide host range. Important species and their hosts are given below:

Weevil	Scientific name	Host range
Ash weevil	*Myllocerus* sp.	Red gram and Egg plant
Ghujhia Weevil	*Tanymecus indicus*	Wheat and Red gram
Rhizome weevil	*Cosmopolites sordidus*	Banana

Pseudo stem weevil	*Odoiporus longicollis*	Banana
Red palm weevil	*Rhynchophorus ferrugineus*	Coconut
Boll weevil	*Anthonomus grandis*	Cotton
Rice weevil	*Sitophilus oryzae*	Stored rice grains


Ash weevil


Rhizome weevil


Red palm weevil

2. As major weed killers: Water hyacinth is the most serious aquatic weed in India, infesting more than 200000 ha of water surface. During 1993-1998, release of biological control agents of water hyacinth (*Eichhornia crassipes*), the weevils *Neochetina eichhorniae* and *Neochetina bruchi* caused significant reductions of the weed. The adults produce characteristic feeding scars on the leaves and petioles. In the larval stage, the insect tunnels into the petioles and the crown of the plant. This feeding results in biotic stress, reduced flowers and seeds, and less vigorous growth.


Neochetina eichhorniae


Neochetina bruchi

3. As a vital pollinator: The oil palm, *Elaeis guineensis*, exists in wild, semi-wild and cultivated states in three land areas of the equatorial tropics, i.e., Africa, South East Asia and America. *Elaeidobius kamerunicus* was identified as the most efficient insect pollinator of oil palm. Both male and female inflorescences of oil palm emit an anise-like fragrance. Female inflorescences reward the weevils with copious nectar production, whereas male inflorescences reward both nectar and pollen.

Distribution: Central and South America; Africa; South and South-East Asia; Australasian – Oceanian.

4. As an associate/ vector of serious disease: Dutch elm disease is a vascular wilt disease which is caused by member of the sac fungi (*Ophiostoma* sp). The fungi are spread from damaging sites by their vectors - elm bark beetles. Two beetle species spread the pathogen, the smaller European elm bark beetle (*Scolytus multistriatus*) and the native elm bark beetle (*Hylurgopinus rufipes*) in Europe. The adult female beetle bores through the bark of dead or dying elm trees and elm logs and creates a tunnel in the wood as she feeds. She lays eggs in the tunnel behind her. The eggs hatch into larvae that begin to feed, creating tunnels at right angles to the maternal tunnel.


Oil palm weevil


Elm bark beetle

Conclusion

Many weevils are considered as pests of major food crops like pulses, rice (under storage condition) and some horticultural crops like banana since they have the ability to damage and kill them. However, some of the members are useful insects like pollinator and weed killers which are known to be farmer friends. Exploitation of these beneficial roles of weevils may serve as the best option in controlling weeds and also in increasing crop yield.

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Hardy Deciduous Shrub (Witch Hazel) - *Hamamelis Sp.*

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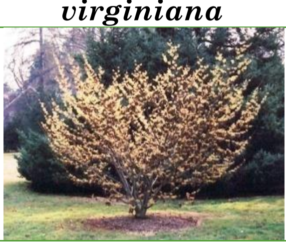
G. Sathish[1], M. Mohanalakshmi[1]

[1]Assistant Professor (Horticulture), Regional Research Station (RRS), Tamil Nadu Agricultural University (TNAU), Vridhachalam, Cuddalore District.

1. Common name: Witch Hazel.
2. Family: Hamamelidaceae.
3. Type: Hardy Deciduous Shrub.
4. Flowering season: Mid-winter – Early spring (Dec. - Feb.).
5. Mature size/ shape: 1-8- 3.0 m high, 1.8- 2.5 m spread.

The name *Hamamelis* is said to come from hama and mela, the greek words for together and fruit, because flowers and fruit can sometimes be found side by side on the same plant. It was discovered in China by the plant collector Charles Marie in 1878 but was relatively unused in Britain for about 20 years after this. These deciduous plants need not be pruned, although if the side branches are cut back in the formative years a small “trunk and tree” effect is produced, rather than the natural bush shape. The plants will withstand cold conditions and even the flowers will not be damaged by a touch of frost. A light, loamy soil suits them best, with an addition of peat or leaf mould at planting time.

Propagation is easiest from seed but they often do not germinate for two years. Sow seed in boxes of soil, peat and sand mixture. The Chinese and Japanese varieties of *Hamamelis are* often grafted onto *Hamamelis virginiana* to give them a vigorous root stock, as cuttings of these varieties are difficult to root. Grafting should be done under glass in the spring. *Hamamelis japonica* from Japan has slightly- fragrant yellow flowers. The variety *Hamamelis japonica arborea* is more vigorous and has darker – coloured flowers, while *Hamamelis japonica zuccariniana* has lemon yellow flowers that do not appear until mid-spring (march). *Hamamelis mollis* from china is often said to be the most beautiful. It has a primrose like fragrance with golden yellow flowers that proliferate from mid-winter to early spring (mid-December to mid-February). *Hamamelis mollis pallida*, a recent variety, produces large, sulphur –yellow flowers in clusters. *Hamamelis virginiana,* the American witch hazel, flowers in the autumn before the leaves fall, and as the flowers are altogether smaller than their Asian counterparts, they are not easily seen. The bark and leaves of this part are the sources of a medicinal oil used in the preparation of bay rum. There are now several new forms and hybrids. Successful varieties include *Hamamelis* x *intermedia* Diana, a red-coloured cultivar, and *Hamamelis* x *intermedia* Jelena with large, coppery flowers and spreading habit, the leaves of both colour well in autumn.

			
Hamamelis virginiana	***Hamamelis mollis***	***Hamamelis japonica arborea***	***Hamamelis japonica zuccariniana***
			
Hamamelis mollis pallida	***Hamamelis* x *intermedia* Diana**	***Hamamelis* x *intermedia* Jelena**	

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Attention Deficit Hyperactivity Disorder - An Overview & Dietary Approaches

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Meenakshi. V[1], Sivasakthi. B[2]
[1]Assistant Professor (FSN), Department of Food Science and Nutrition, Community Science,
[2]Student, Community Science College and Research Institute, TNAU, Madurai -625 104,
College and Research Institute, TNAU, Madurai -625 104.

Abstract
Attention-deficit/hyperactivity disorder (ADHD) is a neuro developmental disorder that affects approximately 5.29% worldwide. Throughout an individual's lifetime, ADHD can significantly increase risk for other psychiatric disorders, educational and occupational failure, accidents, criminality, social disability and addictions. ADHD is highly heritable, although there is no single causal risk factor and non-inherited factors also contribute to its aetiology. It requires long-term cooperation and collaboration among family members, educators, physicians, and other professionals. In this review the prevalence, characteristics, symptoms, diagnostics and dietary intervention are discussed.

Key words: Attention-deficit/hyperactivity disorder; Children; Prevalence; causes of ADHD; World.

Introduction
Attention deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder of childhood and adolescence characterized by pervasive and impairing symptoms of inattention, hyperactivity, and impulsivity according to DSM-IV (Diagnostic and Statistical Manual of Mental Disorders). Although originally thought to remit during childhood, the symptoms of ADHD have also been shown to persist in patients through adolescence and into adulthood.

It interferes with many areas of normal development and functioning in a child's life. Attention-deficit/hyperactivity disorder (ADHD) is among the most commonly diagnosed neuro developmental disorders, affecting approximately 8%–12% of children worldwide, with up to 65% continuing to have ADHD symptoms and neuropsychological impairments in adulthood (Polanczyk et al., 2015).

The World Health Organization (WHO) uses a different name—hyperkinetic disorder (HD)—but lists similar operational criteria for the disorder. Regardless of the name used, ADHD/HD is one of the most thoroughly researched disorders in medicine. ADHD is a heterogeneous disorder, in terms of the multifactorial etiological risk factors, diverse expressions of the symptom domains, comorbid disorders, neuropsychological impairments, and long-term trajectories (Costa Dias et al., 2015).

The etiological heterogeneity in terms of the biological and environmental factors is likely reflected in variation in neural correlates (Fair *et al.,* 2012; Costa Dias *et al.,* 2013, 2015; Karalunas *et al*., 2014), and results in the diverse cognitive and behavioral profiles and developmental trajectories of the disorder (Rajendran *et al*., 2013; Schulz *et al.,* 2017). Children with ADHD are more likely than their peers to experience educational underachievement, social isolation and antisocial behaviour during the school years and to go on to have significant difficulties in the post-school years (Thabet *et al*., 2010).

Characteristics of ADHD
ADHD is a condition characterized by all four of the following:
1. Presence of symptoms of inattention, hyperactivity and impulsiveness.
2. Onset before the age of 7 years and usually from birth.
3. At least moderate impairment of functioning in more than one setting (school, home and health care, i.e., your consulting room).
4. At least moderate impairment of function in several domains (school achievement, friendships, leisure activity or home life).

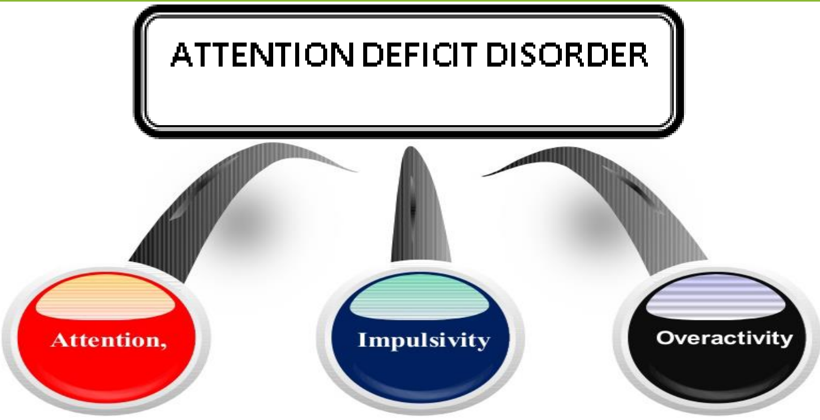

Fig (1): Characteristics of ADHD

DSM IV (Diagnostic and Statistical Manual of Mental Disorders) identifies three subgroups of ADHD – combined, predominantly inattentive and hyperactive– impulsive type.

Symptoms of ADHD

Symptoms of ADHD fall into three groups:
1. Not being able to focus (inattentiveness).
2. Being extremely active (hyperactivity).
3. Not being able to control behavior (impulsivity).

Some people with ADHD have mainly inattentive symptoms. Some have mainly hyperactive and impulsive symptoms. Others have a combination of different symptom types. Those with mostly inattentive symptoms are sometimes said to have attention deficit disorder (ADD) (DSM-V., 2013).

Prevalence

The mean worldwide prevalence of ADHD is between 5.29% and 7.1% in children and adolescents (<18 years) (Willcut *et al.*, 2012). Higher rates of ADHD were found in boys than in girls for all types of ADHD, with the inattentive type most common. Prevalence of ADHD in the screened school age population was estimated at about 4% (DSM V-2013). Geographic location plays a limited role in the reasons for the large variability of ADHD/HD prevalence estimates worldwide (Polanczyk et al., 2007).

Causes of ADHD

The evidence so far points to both genetic and environmental factors playing a role in the aetiology of ADHD.
1. ADHD phenotype is associated with gene mutations in the dopamine transporter gene (DAT1) and the dopamine D4 receptor gene.
2. Environmental effects, including maternal stress and smoking during pregnancy, poor quality early caregiving, perinatal complications and prematurity also play a role in the aetiology of ADHD.
3. The role of food additives and preservatives in children's hyperactivity is controversial.

There is probably a subgroup of children whose hyperactivity could be reduced by carefully applying an exclusion diet, however research in this area is in its infancy and there are real dangers of causing harm if diets are tried without specialist supervision, which is not usually available on the NHS. (Thaper *et al.*, 2011).

Problems Associated with ADHD

There is a high incidence of comorbidity with oppositional defiant disorder (35–50%) and conduct disorders (25%). Similarly comorbid learning disorders, anxiety, depressive and tic disorders all occur with increased frequency. Tic disorder are defined as repeated, sudden, rapid, nonrhythmic muscle movements including sounds or vocalizations. The majority of children with ADHD do not have any neurological symptoms, although ADHD is more common in children with epilepsy and other brain pathology. (Willens *et al.,* 2010).

Diagnosis of ADHD

The actual diagnostic label "ADHD" most commonly has been given by physicians (pediatricians, child psychiatrists, pediatric neurologists) and by licensed psychologists. To identify principles and procedures which, in most cases, should be followed in order to assure that the best diagnostic decisions are reached

1. Use multiple sources of information: In addition to evaluating the child directly by appropriate testing and careful observations, it is very important to get information from parents, teachers, and others in the child's environment in order to achieve a multi-disciplinary, *collaborative* approach to ensure that all points of view are represented.

2. Get information about the child's functioning in different settings: For many years, it was assumed that if a child had ADHD, s/he would consistently exhibit ADHD symptoms and exhibit them equally in every situation. We now know this is not necessarily true. A child with ADHD may be able to sit quietly and watch an interesting TV show or attend intensively to a video game or favorite activity for extended time periods. In undemanding task situations, a child with ADHD may also manage well.

3. Assess all dimensions of ADHD: The syndrome includes significant problems with inattention, impulsivity/hyperactivity, or all three. An assessment for ADHD would be incomplete if it did not include an evaluation of all these components.

4. Obtain and review multiple types of data: Medical status, developmental/social history, cumulative educational records, interviews, careful observations, psycho-educational tests as needed, and checklists for the assessment of attention, impulsivity, and hyperactivity all contribute to a comprehensive evaluation for ADHD (DSM –V., 2013).

Treatment

The management of ADHD includes consideration of two major areas: non pharmacological (educational remediation, individual and family psychotherapy) and pharmacotherapy (Willens *et al*., 2010).

1. Pharmocotheraphy: stimulants, noradrenergic agents, and alpha agonists comprise the available agents for ADHD. The medications used in ADHD have been observed to have pharmacological responsivity across the lifespan for school-aged children, adolescents, and adult groups with ADHD.

2. Non – Pharmacotherapy- Psychosocial Treatments: Parent training using various methods, including small and large parent training groups, individual families, videotapes, and behavioral sessions that include children. In the academic setting, virtually all children with ADHD must cope with organizational and behavioral demands and expectations. Classroom behavioral interventions often involve training the teacher in use of these methods.

Fig (2) Management of ADHD

Dietary Interventions

A specialty diets for ADHD haven't been researched a lot. Data is limited, and results are mixed. Many health experts, though, think that what you eat and drink may help ease symptoms. Experts say that whatever is good for the brain is likely to be good for ADHD.

1. A high-protein diet. Beans, cheese, eggs, meat, and nuts can be good sources of protein. Eat these kinds of foods in the morning and for after-school snacks. It may improve concentration and possibly make ADHD medications work longer.

2. More complex carbohydrates. These are the good guys. Load up on vegetables and some fruits, including oranges, tangerines, pears, grapefruit, apples, and kiwi. Eat this type of food in the evening, and it may help you sleep.

3. More omega-3 fatty acids. You can find these in tuna, salmon, and other cold-water white fish. Walnuts, Brazil nuts, and olive and canola oils are other foods with these in them. You could also take an omega-3 fatty acid supplement. The FDA approved an omega compound called Vayarin as part of an ADHD management strategy.

4. Foods to Avoid With ADHD: **Simple carbohydrates.** Cut down on how many of these you eat such as Candy, Corn syrup, Honey, Sugar, Products made from white flour, White rice and Potatoes without the skins.

Some experts recommend that people with ADHD take a 100% vitamin and mineral supplement each day (Julia *et al*.,2017). Other nutrition experts, though, think that people who eat a normal, balanced diet don't need vitamin or micronutrient supplements. There's no scientific evidence that vitamin or mineral supplements help all children who have the disorder.

Elimination Diets for ADHD

1975, an allergist first proposed (Feingold Diet) that artificial colors, flavors, and preservatives might lead to hyperactivity in some children. Some experts recommend that people with ADHD avoid these substances such as Artificial colors, especially red and yellow, Food additives such as aspartame, MSG (monosodium glutamate), and nitrites. Some studies have linked hyperactivity to the preservative sodium benzoate, Sugar, Caffeine.

Fig (3): Example for elimination of Diet for ADHD

Conclusion

Attention Deficit Hyperactivity Disorder (ADHD) Characteristics include age-inappropriate levels of motor activity, impulsivity, inattention, or all three. Differential diagnosis is difficult since physical, social, and psychological conditions share characteristics with ADHD. A lack of clear understanding of ADHD and the importance of its diagnosis and treatment still exists among many members of the community including parents, teachers, and healthcare providers. More basic and clinical research will improve methods of diagnosis and information dissemination. Even before further advancements in science, strong partnerships between clinicians, and patients with ADHD may be the best way to reduce the negative impacts of this disorder. With early diagnosis, understanding, treatment, and management, they can be helped to realize their potential and make valuable contributions to society. The successful social and academic education of the child with ADHD, however, cannot be left to chance. It requires long-term cooperation and collaboration among family members, educators, physicians, and other professionals.

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Nutraceuticals and Bone Health Management

Article ID: 35067
Dr. V. Meenakshi[1]
[1]Assistant Professor (FSN), Department of Food Science and Nutrition, Community Science College and Research Institute, Tamil Nadu Agricultural University, Madurai- 625 104.

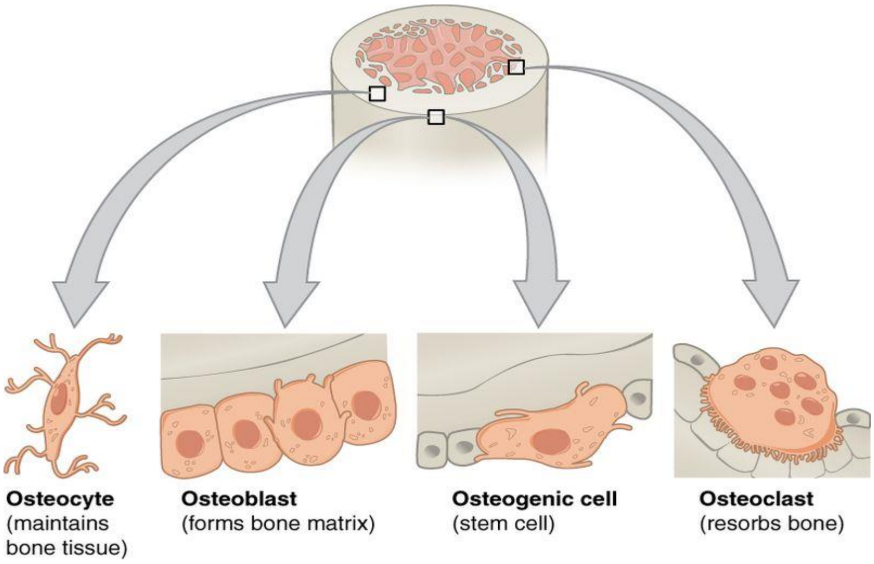
Nutraceuticals an Overview

The consumer's attitudes are changing from adequate nutrition to optimal nutrition. The changing perception about nutrition and bioactive compound and its effect on human health gave new arena in the field of nutraceuticals. Nutraceuticals are currently receiving recognition as being beneficial in coronary heart disease, obesity, diabetes, cancer, osteoporosis and other chronic and degenerative diseases such as Parkinson's and Alzheimer's diseases. Nutraceuticals meaning has been modified by Health Canada (1998), which defines nutraceutical as: A product isolated or purified from foods, and generally sold in medicinal forms not usually associated with food and demonstrated to have a physiological benefit or provide protection against chronic disease.

Osteoporosis results from an imbalance in the natural process of bone remodeling, a continuous cycle for bone formation and bone resorption. The range of musculoskeletal conditions includes back pain, osteoporosis, rheumatoid arthritis, osteoarthritis and bodily injuries. Nowadays various therapies are available targeting osteoporosis like acupuncture, allopathy, homeopathy, naturopathy etc. Consumer focus is now shifting towards the natural alternatives to avoid side effects associated with the drug therapy.

Bone Formation and Remodeling

There are two main types of bone in the skeleton. Osteoblasts and osteoclasts differ in their function in the maintenance of bones. Osteoclasts originate from hematopoietic precursor cells responsible for bone formation (**involved in the formation and mineralization of bones**), while osteoblasts are derived from mesenchymal cells serve for bone formation (**involved in the breakdown and resorption of bones**). Both of these cell types are involved in the repair of broken bones. Osteocytes are terminally differentiated osteoblasts which are present in mineralized bone and help to control the timing and site of bone remodeling.



Growing Burden of Bone Problem

As suggested by WHO Bone Health (Osteoporosis and Fracture) is mainly based on Bone Mineral density. Bone Mineral Density is transformed into a T-score, which reflects the number of standard deviations (SD) above or below the mean in healthy young adults.

WHO Criteria for clinical diagnosis of osteoporosis

BMD	Bone Mineral Density
T-score ≥ -1	Normal
T-score > -2.5	Low bone mass
T-score ≤ -2.5	Osteoporosis
T-score ≤ -2.5 with existing fracture	Severe osteoporosis

WHO and the National Osteoporosis Foundation define osteoporosis purely on a bone mineral density (BMD) T-score more than 2.5 standard deviations below young normal reference ranges for the spine, hip or radius? Osteoporosis is a multifactorial disorder associated with low bone mass and enhanced skeletal fragility. Although most prevalent in older females, some men are at high risk as well. Risk factors in men and women include smoking, family history of fracture, age greater than 65 years and low BMI. Obesity has also been associated with a greater risk of fracture in men. Secondary causes of osteoporosis include chronic treatment with glucocorticoids, gastrointestinal disorders, diabetes mellitus (T1D, T2D), rheumatoid arthritis, liver disease, gluten enteropathy, multiple myeloma and other hematologic disorders. However, primary osteoporosis is most often related to either postmenopausal estrogen loss or age-related deterioration of the microarchitecture; both are due to uncoupling in the remodeling unit.

Osteoporosis, is a major risk factor for fractures of the hip, vertebrae, and distal forearm. Hip fracture is the most detrimental fracture, being associated with 20% mortality and 50% permanent loss in function. The early diagnosis of osteoporosis is very important, because individuals diagnosed with osteoporosis have 2.74 times greater chance of presenting bone fractures within 1 year, and those with osteopenia have 1.73 times greater chance and these morbidity may be prevented by early treatment (Bhaskar Borgohain *et al*.,2017).

Consequences of Osteoporosis

Age-related bone loss is asymptomatic, and the morbidity of osteoporosis is secondary to the fractures that occur. Common sites of fracture include the spine, hip, forearm and proximal humerus. Fractures at the hip incur the greatest morbidity and mortality, and give rise to the highest direct costs for health services. Their incidence increases exponentially with age. Osteoporotic fractures at other sites are generally of less economic significance, but they also give rise to significant morbidity and, in some instances, to increased mortality. They occur more commonly than hip fractures at younger ages, and their neglect in evaluating assessment strategies disadvantages the younger segment of the osteoporotic population. The remaining lifetime probability of osteoporotic fractures in women at the age of 50 years exceeds 40% in developed countries. For hip fracture alone, the remaining lifetime probability at the age of 50 years exceeds 20% in women in these countries. In many regions of the world, the risks in men are about half those of women. The number of osteoporotic fractures is certain to increase in both men and women (by more than 3-fold over the next 50 years) as a result of the ageing population. The major increases will occur outside of Europe and the United States, particularly in Asia and Latin America. Over and above changes in population demography, the age- and sex specific incidence of osteoporotic fractures appears to be increasing in developing countries. This may more than double the expected burden of osteoporotic fractures over the next 50 years. (WHO, 2004).

Nutraceuticals for Bone

Nutraceuticals with high levels of one or more of these properties could ameliorate the symptoms of arthritis. Antiarthritic plant foods, when consumed regularly to the optimum level, could be extremely safe without the adverse effects of currently used NSAIDs (Non-Steroidal Anti-inflammatory Drugs) and immunesuppressors. Antiarthritic foods include tea leaf (*Camellia sinensis*), cinnamon, ginger, coriander seed, turmeric, black pepper, fenugreek seed, carrot and black berry (*Syzygium cumini*). Common people should understand the medicinal value of natural whole food nutraceuticals which can be consumed in its natural form.

Calcium

It is essential to have sufficient calcium intake during teenage years as it affects peak bone mineral density which can later help in preventing osteoporosis. To achieve adequate peak bone density, adolescent calcium intake can go up to **1600mgd^{-1}.** Calcium from the bones can be mobilized by parathyroid hormone-mediated bone breakdown if loss of calcium from the extracellular fluid exceeds its intake via the gut in order to protect neuromuscular system dependent on calcium leading to osteoporosis.

Magnesium

In human body, about 60% of entire Magnesium (Mg) is reserved in the bones either on hydroxyapatite surface or in hydration shell surrounding the crystals. It works as an abundant source of exchangeable Mg in order to maintain serum Mg levels to perform numerous physiological functions in the body. One of the approaches to prevent osteoporosis is by building healthy bones throughout life. Mg deficiency directly affects bone wherein it alters the apatite crystal's structure and leads to larger crystals that cannot bear normal load and vice-versa. Similarly, Mg deficiency causes reduction in the levels of PTH, which is crucial for normal development of bone and homeostasis of calcium.

Potassium

It helps to maintain alkaline environment and lowers the need for salts in the skeletal microenvironment to neutralize the endogenous acid which is produced from the acid generating foods like meat. Potassium thereby helps in conserving bone calcium which might otherwise be used up to regulate the pH. Thus, foods rich in potassium might help in prevention of osteoporosis. Generally, for bone health, 3500–3800mg/d potassium dose is recommended for ages 1–3years, 3800mg/d for ages of 4–8years, 4500mg/d for ages of 9–18years and 4700mg/d for ages of 19years and above.

Boron

Boron stabilizes and increases the half-life of vitamin D and estrogen and thus exhibits positive results on bone health by preventing loss of calcium and bone demineralization. Prunes are an abundant source of boron and other sources include foods such as resins, dried apricots and avocados. There are no recommended levels for boron intake; however, 3mg/d is associated with gains in bone weight.

Copper

Serving as a cofactor for all antioxidant enzymes, it also eliminates the free radicals in the body, caused by activation of osteoclasts. Further, it also helps in sustaining the ideal state of bone matrix. Daily intake of copper is recommended in adults is 0.9mg/day for bone health.

Melatonin

Melatonin is an endogenous hormone secreted from the pineal gland of the brain. It occurs in various fruits and vegetables, particularly in tomatoes, cucumbers and bananas. The body can able to secrete 5-25 microgram/day. The secretion of melatonin is high during 1-3 years of age. It is highly lipophilic molecule it is able to penetrate lipid membrane of cells readily and inhibit oxidase enzymes. Usually, osteoclasts utilize oxygen radicals and initiate bone resorption. Melatonin may halt this activity**.** Second action is through its binding to its various intracellular receptors and helps in bone cell regulation. Third mechanism is melatonin itself have a local hormone action on bone. Maturation of Osteoblasts and secrete measurable amount of osteocalcin (bone marker), thereby it acts as paracrine manner. Minimal Toxicity: 0.3 to 15 mg daily.

L-carnitine

It is found in skeletal and cardiac muscle. It can also be obtained from dairy and meat produce. Daily intake 100-200 micro mole. L-carnitine express **Insulin like growth factor** (IGF). IGF mediates osteoclast differentiation and maturation.

Conjugated Linoleic Acid

CLA main sources are meat and dairy. Based on the source of production it is from milk. CLA is produced by specific bacteria in the rumen via bacteria modification of linoleic acid in the animal's diet & absorbed in ruminant & enters its tissue. CLA is now recognized as excretory metabolite of bacteria or metabolite intermediate that has been released by bacteria. LA production in cow is mainly for symbiotic purpose (longevity of cow, for bacteria –host organism).

CLA may affect the synthesis of PGE1 by competing with omega 6 PUFA substrate there by with a reduction in detrimental formation of PGE2. Autocrine and paracrine factors are secreted by cells present within bone tissue and have more localized targets of action. Prostraglandins (PGE1 and PGE2) act via binding to various membrane receptors and their effects are mediated through Insulin like Growth factor (IGF). PGE1 is thought to increase bone formation, inhibits osteoclasts. PGE 2 can inhibit bone formation and promote osteoclasts activity.

Phytoestrogens

It is found in flax seeds, soy bean chick pea. Phytosterol acts like oestrogen and have same effects of oestrogen.

Poly Unsaturated Fatty Acids

Certain PUFAs may influence the structure and function of brush border of intestine and Kidney tubules. As consequences this may influence the absorption from gut and renal resorption of calcium from kidney.

Food Sources that Aid in Bone Health

Citrus fruits: Citrus fruits such as orange, grapefruit, lemons etc. are rich sources of micronutrients like potassium, magnesium, vitamin C and folic acid along with limonoids and flavonoids. Studies have indicated that limonoids and flavonoids exhibit antioxidant action and have the capacity to improve bone health.

Onion: Onion, botanically Allium cepa L., is a bulb-shaped vegetable which is extensively used globally because for its strong flavor and numerous health benefits. Onions are rich source of flavonoids such as Quercetin, rutin and its organo-sulfur conjugates that possess strong antioxidant activities. Few pre-clinical studies have presented that onion inhibits resorption of bone and differentiation of osteoclast and thus maintains normal bone mineral density.

Green Tea: Green tea consists of polyphenolic compounds known as catechins which include epigallocatechin gallate, epicatechin gallate, epicatechin and epigallocatechin (Ko, Lau, Choy, &Leung,2009). Epigallocatec in-3-gallate has found to decrease bone resorption by causing osteoclastic cell death.

Berries: Berries have anti-oxidant, anti-inflammatory activity and also modulate some enzymes, cellular singling pathways and gene expression. For example, it was found that trans-retinoid acid along with raspberry ketones stimulates osteoblast differentiation by improving osteocalcin expression in stem cell culture system.

Plums: Dried plums or prunes contain carbohydrates, vitamin A, B and K, potassium, calcium, magnesium, boron, selenium, dietary fibres and polyphenols like chlorogenic acid, rutin and proanthocyanidin. Both boron and selenium are responsible for bone metabolism and maintaining BMD. Polyphenols found in plum decrease bone resorption.

Resveratol: Dried plums or prunes contain carbohydrates, vitamin A, B and K, potassium, calcium, magnesium, boron, selenium, dietary fibres and polyphenols like chlorogenic acid, rutin and proanthocyanidin. Both boron and selenium are responsible for bone metabolism and maintaining BMD. Polyphenols found in plum decrease bone resorption.

Milk Products: Milk and milk derived products are rich in calcium and useful foods for prevention of osteoporosis. Besides calcium, they are also abundant supplies of proteins, lipids, potassium, sodium, zinc, phosphate, and vitamins A and B2. Functional compounds in milk like casein phosphopeptide, milk basic protein (MBP) and lactoferrin are beneficial for bone health.

Curcumin *(Curcuma longa)*

Traditionally curcumin is used as a coloring agent in Indian subcontinent and Curcumin is demonstrated both invitro and in vivo to against bone loss.

Resveratrol

Resveratrol has been isolated from various plants including grapes, berries, and peanuts. Studies have shown that resveratrol suppresses the NF-κB activation a key player of bone loss. NF-κB is a protein complex that controls transcription of DNA, cytokine production and cell survival.

Quercetin *(Allium cepa)*

Quercetin is a flavonoid found in a variety of fruits and vegetables, and has an especially high concentration in onions. This flavonoid is believed to either activate osteoblast or inhibit the Oosteoclast differentiation, thus regulating bone metabolism.

Genistein

Genistein an isoflavone, was first isolated in 1899 from the dyer's broom, Genista tinctoria. Although found mostly in soy, isoflavone is also found in a wide variety of foods such as peanut, green peas, chick peas and alfalfa. A number of in vitro and in vivo studies have demonstrated that genistein has the potential to prevent bone loss.

Conclusion

A traditional therapy which provides bone strength and prevents bone loss is an alternative safe therapy. The pharamco drugs for osteoporosis provide better healing nature and side effects. The nutraceuticals present in traditional foods are well documented and studies are carried out both invivo and invitro. It is necessary to known the dosage level of nutraceuticals, allergicity and toxicity in order to get better bone health.

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Bio-fortification of Horticultural Crops: New 'Green Revolution' for Nourishing Future

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Archana Mahida[1], Tandel Y. N[1]

[1]Department of Fruit Science ASPEE College of Horticulture and Forestry Navsari Agricultural University, Navsari-396450.

Abstract

The Green Revolution that began in the 1940s and 50s brought about large increases in crop yields and saved millions of people from mass famine. Though it succeeds to overcome the hunger of huge population, it couldn't show the same magic to combat the hidd en hunger i.e., a condition of under nutrition, where the body lacks essential vitamins and minerals that keep people healthy. Yet malnutrition remains widely prevalent around the globe. And, while many people eat enough calories, many do not get enough nutrients. According to food and agriculture organization of the United Nations almost a third of world's nutrient and suffer from hidden hunger. Deficiencies in micronutrients such as zinc, iron and vitamin A can cause profound and irreparable damage to body – blindness, growth stunting, mental retardation, learning disability, low work capacity and even premature death. Now, plant breeders and biotechnologists are working on a new Green Revolution to make crops produce more nutrients by a process called biofortification.

Introduction

Bio fortification derived from Greek word "bios" means "life" and Latin word "fortificare" means "make strong". Bio fortification is the process by which the nutritional quality of food crops is improved through agronomic practices, conventional plant breeding, or modern biotechnology.

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.

Need of Bio Fortification

1. To reduce the percentage of hidden hunger: The greatest concern lies with deficiencies in Vitamin A, iron, iodine, and zinc.
2. Increasing mineral concentrations in edible crops: If mineral elements are present in soil, either agronomic or genetic strategies can be developed to increase their acquisition, or mineral element can be added as soil or foliar fertilizers.
3. Trace elements need assessment to human being: some mineral that are only need in small amount, but essential for good health, normal brain growth, healthy ageing, strong immune system, good performance of human being.

Richness of Fruits and Vegetables

Sources	Fruits	Content	Vegetables	Content
Vitamin A	Mango	4800 IU/100g	Mustard leaves	4370 IU/100mg
Vitamin B1	Cashew	630 mg/100g	Chillies	0.55 mg/100g
Vitamin B2	Beal	1191 mg/100g	Fenugreek Leaves	0.31 mg/100g
Vitamin C	Vitamin C	1000 – 4000 mg/100g	Drumstick Leaves	220 mg/100g
Carbohydrates	Apricot	72.81%	Tapioca	38.1%
Protein	Cashew	21.20%	Pea	7.2 g/100g
Fiber	Guava	6.90%	Amaranthus	1.0%
Calcium	Litchi	0.21%	Agathi	1130 mg/100g
Phosphorus	Cashew	0.45%	Kaintha	0.11%
Iron	Karonda	39.1%	Agathi	83.9%

Forms of Bio Fortification

There are three forms of bio fortification: agronomical biofortification, improved plant varieties through conventional breeding, special method i.e., nutritional genetic modification (Nutrieogenomics), genetic engineering and transgenic method. Agronomical bio fortification: - Agronomical bio fortification of food crops is strategy, along with breeding /genetic engineering to reduce dietary deficiencies.

Agronomical bio fortification, especially in the case of foliar application, is highly effective for zinc, selenium, iodine and cobalt. As an effective strategy for reducing micronutrient deficiency, zinc provides one of the best and quicker avenues for agronomical bio fortification.

It is considered as short-term solution, safe and accurate system to process fertilizers. Agronomic bio fortification is flexible, fast and cheap and can be used for all species and cultivars. Bio-fortification through Conventional breeding: - genetic variations in essential nutrient content are taken in consideration to improve the levels of minerals and vitamins in crops by conventional breeders' programs.

Using this method, plant breeders search seed or germplasm banks for existing varieties of crops which are naturally high in nutrient. Then they crossbreed these high nutrient varieties of crops, to provide a seed with high yields and increased nutritional value. Furthermore, this approach has the blessing of vocal opponents to genetic engineering.

Because this approach is likely to be the most expedient method to improve plants; several international organizations have initiated programs to improve the nutritional content of crops through breeding programs. Harvest-Plus, an organization working on bio fortification, is investing $14 million annually to boost three key nutrient-vitamin A, iron and zinc. Genetic engineering approach: - With the advent of molecular biology, genes are characterized and utilized to engineer plant metabolism for biofortification.

Genetic engineering is more precise and involves isolating individual genes from the wild relatives of domesticated crops or other species that code for increased production of certain nutrients and transferring them into the plant. Pathways from bacteria and other organism can also be introduced into crops to exploit alternative pathways for metabolic engineering. Thus, these technologies provide a powerful tool that is unconstrained by the gene pool of the host.

It is also possible for different genes coding for increased levels of different nutrients to be "stacked" in crop using genetic engineering methods, so that a crop can be bio fortified with more than one desired nutrient. Transgenic approach for bio fortification: - In absence of genetic variation in nutrient content among varieties, breeders have nothing to work with.

This is where transgenic approaches can be a valid alternative. Nutritional genomics studied the relationship between genomics, nutrition, and health. The ability to rapidly identify and characterize genre function and then utilize these genes to engineer plant metabolism has been a driving force in recent bio fortification efforts.

This was made possible by the rapid development of whole genome sequencing, high expression analysis, and metabolite profiling in variety of organisms. Although the possibilities associated with transgenic approaches keep pant biologists optimistic, regulatory hurdles associated with this technology make commercial applications difficult.

However there has been a movement to work around patent to deliver biotechnology to poor farmers of the worlds. Regrettably, the current political and economic landscape is not receptive to this technology being widely applied to host of different crops.

Targeted Horticultural Crops

1. Cassava: Cassava, an important crop in many developing countries, contains iron and zinc only in low concentrations. Thus, the focus of bio - fortification initiatives is exclusively on increasing beta-carotene concentration (Montagnc et al., 2009).

Analyzing 632 accessions from the CIAT germplasm collection of 5500 accessions and detected germplasm with beta - carotene concentrations above 20 µg/ g, suggesting a high genetic variability that would make it possible to successfully biofortify cassava and meet the daily retinol requirements of adults (Graham et al., 1999).

2. Orange sweet potato (OSP): To increase targeted level of 30 ppm of provitamin A in sweet potato, International Potato Center (CIP) in south Africa and Uganda (Harvest plus) + National agriculture Research and Extension System (NARES) started project in 2002-2007 and the first variety released in 2002.This variety have ability to grater provitamin A retention more than 80% after boiling or steaming and at least 75% after solar or sun drying but also high yielding and drought tolerant.

Harvest Plus and its partners distributed OSP to more than 24,000 households in Uganda and Mozambique. Biofortified varieties are now being introduced in many parts of Africa and South America, as well as China. In 2009, CIP launched its Sweet Potato for Profit and Health Initiative (SPHI), which seeks to deliver OSP to 10 million households in Africa by 2020.

3. Potato: CIP (International centre for potato) started project on development of Fe rich potatos by conventional biofortification method in 2009 and the varieties will be release in 2017.

4. Cow pea: Pioneer research on biofortifcation of cow pea has initiated G.B. Pant University of Agriculture and Technology, Pantnagar, India. Two early maturing high iron and zinc fortified varieties namely Pant Lobia-1(82ppm Fe and 40ppm Zn), Pant Lobia-2(100ppm Fe and 37 ppm Zn) has been developed by conventional plant breeding and released in 2008 and 2010.Pant Lobia -3 (67 ppm Fe and 38 ppm Zn), Pant Lobia-4(51ppm Fe and 36 ppm Zn) released in 2013 and 2014 respectively. Brazil also released three varieties of high -iron cowpeas, developed by Embrapa, in 2008 and 2009 and bio availability.

5. Nutri banana: Breeding banana/plantain (Musa) is complex, as commercial varieties are sterile triploids (3X). Among the fertile groups, a high degree of cross incompatibility can exist. Further, the Musa crop cycle is long. Genetic engineering method of biofortification is suitable for banana because most of the edible bananas are vegetative propagated and transgene outflow are minimum and therefore genetically modified bananas can be grown alongside non-GM bananas in the same field.

Also, since the GM bananas are sterile, the existing diversity of bananas in India will not be affected and there won't be any heritable mixing of GM and non-GM cultivars in nature. Unfortified bananas have 0.4 mg/100 gm Fe of banana while the fortified banana would supplement this to 2.6 mg/ 100grams.The bio fortification of banana by increasing their beta carotene (up to 20ppm), alp hatocopherol and iron content. Biofortification works on banana will be beneficial where bananas are the major staple food source and good consumer acceptance.

The biofortification works on banana had been initiated at Queensland University of Technology (QUT), Australia to develop provitamin A (ß- carotene), alfa tocopherol and iron rich varieties besides they succeed in improving the disease resistant varieties against Banana Bunchy Top Virus (BBTV) and Fusarium wilt. These varieties are under field and se lection for enhanced level of micronutrients that may match pro vitamin A (PVA) and iron requirements is desirable for India.

6. Beans: Iron (Fe) content in common bean is about 50 parts per million (ppm) and target in biofortification of bean by conventional breeding is 94 ppm, biofortified beans provide about 60% of the Estimated Average Requirement (EAR). Average bean yields in Rwanda.

Non-biofortified beans produce approximately 0.8 tons/hectare (bush and climbers combined) but biofortified bush beans yield around 1.5 t/ha and biofortified climber beans 2–3 t/ha. Among the different varieties released in Rwanda in 2012 and 2014 MAC-42 from CIT contains 91ppm iron and ability to resistance against anthracnose and bean common mosaic virus and ability to produce 3.5t/ha.

7. Tomato: Lycopene is a potent antioxidant with the potential to prevent epithelial cancers and improve human health. Therefore, there is considerable interest in elevating the levels of carotenoids in tomato fruit by genetic manipulation and thereby improving the nutritional quality of the crop.

The Psy-1 enzyme catalyzes the first committed step of the carotenoid biosynthesis pathway by producing phytoene from GGPP (geranylgeranyl diphosphate). In order to increase the carotenoid content of fruit, the Psy-1 gene was constitutively expressed in tomato (Bergougnoux, V., 2014).

To enrich the anthocyanin content of the fruits of a commercially cultivated tomato cultivar, Arka Vikas by fruit specific expression of two transcription factors Ros1 and Del by Agrobacterium-mediated transformation. The average anthocyanin content of the transgenic fruit was 0.1 mg g-1 fresh weight, which were 70-100 folds higher than that of the control fruits (Maligeppagol, M. et al., 2013).

Tomato plants can tolerate high levels of iodine, stored both in the vegetative tissues and fruits at concentrations that are more than sufficient for the human diet and conclude that tomato is an excellent crop for iodine-biofortification programs. The fruit concentration of iodine detected in 5 mM iodide–treated plants was more than enough to cover a daily human intake of 150 µg (Martina L, et al., 2011).

8. Carrot: Genetically engineered carrot containing increased Ca levels may boost Ca uptake, thereby reducing the incidence of Ca deficiencies such as osteoporosis. Transgenically modified carrots expressed increased levels of the plant Ca transporter SCAX1 (Park M.K and Lee, Choe.2003).

9. Cauliflower: Pusa Betakesari: This is the first ever indigenously bred bio-fortified beta carotene (800 – 1000 µg/100 g) rich cauliflower variety, an attempt to tackle beta carotene deficiency related malnutrition problem in India 10. Common bean A new "super food" for Colombia on June 9th, 2016, two biofortified varieties of iron + zinc beans were released in Colombia in Barichara, Santander.

The release of these biofortified bean varieties BIO-101 and BIO-107 with high content of iron (83 ppm) and zinc (44 ppm). It is the first time biofortified beans have been released in the Andean zone of Colombia, with the departmental governments of Santander.

Advantages of Biofortification

1. Capitalizes the regular daily intake of food staples. Implicitly targets low-income households.
2. After the one-time investment to develop fortified seeds, recurrent costs are low; and fortified seeds shared internationally.
3. Once in place, the biofortified crop system is highly sustainable.
4. Fortified seed not incur a yield penalty. May have important indirect effects in increasing farm productivity by helping plants resist to disease and other environmental stresses.
5. To overcome the mal-nutrition in human beings.
6. Increment of nutritional quality in daily diets.
7. Improvement of plant or crop quality and increment of variability in germplasm.

Building Blocks for Global Delivery

For biofortification to reach scale and be truly sustainable, a number of institutions must become involved in establishing an enabling environment.

This includes recognition of biofortification among global normative and regulatory agencies, integration into development policies and programs funded by multi-lateral institutions, uptake by private sector entities, and incorporation into development programs being implemented on the ground, both in target countries and beyond.

This enabling environment is essential to encourage the scaling up of biofortified crops and to support national level actors in various spheres. Efforts are underway to integrate biofortification into global standards and guidelines, such as the Codex Alimentarius, the food standards-setting agency administered jointly by the World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO) and recognized by the Sanitary and Phytosanitary Agreement (SPS) of the World Trade Organization (WTO) as its reference organization.

Beyond their individual investments and activities, multi-lateral institutions, including the World Bank, the African Development Bank, the World Food Programme, and the World Health Organization, collectively influence national government policymakers and operational partners.

The World Bank is now implementing a number of projects supporting biofortification, including the Multisectoral Food Security and Nutrition Project in Uganda, which is accelerating the scale -up of orange sweet potato and iron beans. As a convener of development partners, the Bank plays an important role in encouraging nutrition sensitive agricultural approaches, including biofortification, in areas such as the Global Donor Platform for Rural Development.

The African Development Bank's new "Banking on Nutrition" technical partnership is implementing a multi-sectoral and integrated approach to nutrition interventions, including the integration of biofortified crops.

The World Food Programme's (WFP) Purchase for Progress program is very interested in local purchase of biofortified crops, and partnerships are being developed in several countries. For example, in Rwanda, local iron bean production is purchased and stored in WFP warehouses for later emergencies.

In 2017 the WHO Nutrition Guidance Expert Advisory Group is expected to issue a recommendation and guidelines on bio fortification as a public health nutrition intervention. One step in the process will be the publication of papers discussed in 2016 at an expert consultation held at the New York Academy of Sciences.

Private Sector

As crop development programs increase the number of released varieties of biofortified crops, seeds from these varieties must be made available to farmers. In countries with robust private seed systems that reach smallholder farmers, private seed companies are a natural partner.

In some cases, Harvest-Plus has brokered agreements between seed companies and interested NGOs or government entities to ensure that there will be a market for the seed produced by the private sector, reducing the risk associated with that private sector investment.

While the private sector has predominantly taken up hybrid crops, interest in a wider variety of crops has increased as the business case has been developed. Involving private sector seed companies not only in marketing, but also in developing and testing biofortified varieties, shortens the time to market and lays the groundwork for sustainability.

Conclusion

Biofortification is a cost-effective, feasible means of reaching populations who may have limited availability and access to diverse diets, supplements, or commercially fortified foods. Because biofortification combines increased micronutrient content with preferred agronomic, quality, and market traits, biofortified varieties match or outperform the usual varieties that farmers grow and consume.

Marketed surpluses of biofortified crops make their way into retail outlets in both rural and urban areas, reaching additional populations who may be likely to suffer from micronutrient deficiency.

A one-time investment in plant breeding yields micronutrient-rich varieties for farmers to grow for years to come, and the same varieties can be evaluated in other target geographies with similar agro ecological conditions, thus multiplying the benefit of the initial investment.

Biofortification is one solution among many that are needed to solve the complex problem of micronutrient deficiency, and it complements existing interventions. While the right mix of interventions is country, we can scale up the use of biofortified crops has the potential to benefit millions of people.

Future Vision

To reach its full potential, biofortification must be integrated as a core activity within a range of global institutions:

1. Supply: Agricultural research entities, both public and private, come to recognize high mineral and vitamin content as core plant breeding objectives; varietal release committees make minimum levels of minerals and vitamins a requirement for approval for release (in addition to the standard agronomic traits, such as high yield).

2. Policy: A wide range of national and international public officials come to recognize the significant impact of biofortification for improving and sustaining public health, as well as the high economic return to investments in biofortification and the legitimacy conferred by international recognition (especially by standards bodies).

3. Demand: Both rural and urban consume rs come to see the value of, and demand, high mineral and vitamin content in their foods.

4. Improving the efficiency with which minerals are mobilized in the soil.

5. Enhancing the mineral uptake efficiency of the important crops.

6. Expanding the understanding of mineral accumulation and the transport within the plant body.

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Eco and Environmentally Friendly Buildings

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Varnam Radhika[1]

[1]Research Scholar, Department of Resource Management and Consumer Sciences, College of Community Science, Professor Jayashankar Telangana State Agricultural University, Hyderabad, 500030, Telangana, India.

Abstract

Now a day's eco-friendly buildings are trending and most of the people interested to construct eco-friendly buildings. The main aim of this paper is to know about eco-friendly buildings and their efficiency when compared to normal buildings. How the green buildings were used what are the benefits which practices are followed were covered in this paper. How eco-friendly buildings improves the environment conditions.

Keywords: Eco-friendly, Environmentally friendly, Buildings, Practices, 3Rs.

Introduction

Eco friendly term also has the synonyms like environmentally friendly/ nature friendly/ green, sustainable. In recent years, terms like "going green" and "eco-friendly" have become buzz words on talk shows, commercials and product packaging. The term "eco-friendly" has been used for so many different products and practices; its meaning is in danger of being lost. By understanding the true meaning of eco-friendly, you can implement the practices that will lead to healthier living for the planet and its inhabitants, big and small. Eco-friendly/ environment friendly literally means earth-friendly or not harmful to the environment. This term most commonly refers to products that contribute to green living or practices that help conserve resources like water and energy. Eco-friendly products also prevent contributions to air, water and land pollution.

A Building Green/Eco-Friendly

1. A green building, also known as a sustainable building, is a structure that is designed, built, renovated, operated, or reused in an ecological and resource-efficient manner.
2. Green buildings are designed to meet certain objectives such as protecting occupant health; improving employee productivity; using energy, water, and other resources more efficiently; and reducing the overall impact to the environment.

Eco Friendly/ Environment Friendly Homes

1. Eco friendly homes (also known as Green building or green construction or sustainable building) refers to a structure and using process that is environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation, and demolition.
2. An eco-house/ Green home is a type of house designed to be environmentally friendly and sustainable, while also focusing on the efficient use of "energy, water, and building materials."
3. This requires close cooperation of the design team, the architects, the engineers, and the client at all project stages.
4. The Green Building practice expands and complements the classical building design concerns of economy, utility, durability, and comfort.
5. Although new technologies are constantly being developed to complement current practices in creating greener structures, the common objective is that green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by.

Efficiently Using Energy, Water, and Other Resources

Practices:

1. Construct Rain water harvest pit
2. Recycle grey water

3. Install a Low-Flow Showerhead or taps
4. Turn the shower or tap off when you soap up, then back on while you rinse.
5. Fix the Leak
6. Use a Pro Car Wash
7. Add a water-saving aerator to the tap
8. Minimize the use of kitchen, bath, and other ventilating fans or install a timer switch on them.
9. Maintain refrigerator at 35 to 40 F and freezer section at 0 to 5 F. Maintain standalone freezers at 0 F. Choose a refrigerator/freezer with automatic moisture control. Keep your refrigerator door closed whenever possible.
10. Use of energy saving bulbs and tubes for lighting.
11. Install compact fluorescent lamps in the fixtures which receive high use.
12. Control outdoor lights with sensor timers so they stay off during the day.
13. Install motion sensors for light and water systems.
14. Add insulation to basement walls.

Protecting Occupant Health and Improving Employee Productivity

Practices:

1. Keep the house dry, clean, pest-free, good ventilated and keep it safe.
2. Avoid contaminants and keep it maintained.
3. Improved ventilation systems.
4. Enhanced Indoor Air Quality Measures.
5. No and low-VOC paints, adhesives, sealants and solvents.
6. Low or formaldehyde free cabinets and countertops.
7. Continuous exhaust bathroom ventilation and kitchen exhaust fans, all externally vented.
8. Avoid High-Hazard Cleaning Products.

Reducing and Recycling Waste, Pollution and Environmental Degradation

Practices:

1. Recycling unused or waste products/ materials like paper, glass, plastic etc. helps in reducing waste, pollution and environmental degradation
2. Recycle food packaging. Most community recycling programs accept cereal and cake mix boxes, beverage bottles and cans, and steel soup, vegetable, and fruit cans.
3. Choose fresh and local instead of packaged food. When you buy fresh produce, you not only enjoy food that tastes better and is often healthier, you eliminate cans, boxes, or bags that you have to throw away or recycle.
4. A similar concept is natural building, which is usually on a smaller scale and tends to focus on the use of natural materials that are available locally.
5. Other related topics include sustainable design and green architecture. Sustainability may be defined as meeting the needs of present generations without compromising the ability of future generations to meet their needs.
6. Although some green building programs don't address the issue of the retrofitting existing homes, others do.
7. Green construction principles can easily be applied to retrofit work as well as new construction.

Green Building Facts (Compared with Normal Buildings)

1. 35% reduction in potable water use.
2. 50% savings in overall energy consumption.
3. 88% reduction in lighting consumption.
4. 80% of materials used are either recycled or recyclable.
5. 20% of the building's energy requirement is provided by photovoltaic.
6. 15-20% less load on AC thanks to aerated concrete blocks used in facades.
7. Zero water discharge building.
8. 90% of building daylight.
9. 75% of occupants have outside view.

Green Building Benefits

Green building is not a simple development trend; it is an approach to building suited to the demands of its time, whose relevance and importance will only continue to increase. The benefits to green building are manifold, and may be categorized along three fronts: environmental, economic, and social.

Environmental Benefits

1. Emissions Reduction.
2. Water Conservation.
3. Storm water Management.
4. Temperature Moderation.
5. Reduction of Wastage.
6. Enhance and protects bio diversity and eco systems.
7. Improve air and water quality.
8. Reduces the waste streams.
9. Conserves and restores natural resources.

Economic Benefits

A common impression about green building is that the green premium is too expensive to be considered economically feasible. However, studies have shown that the costs of green buildings are not substantially higher than regular development projects. Higher construction costs can generally be avoided by the inclusion of green design from the outset of the project. Additionally, green buildings provide an assortment of economic advantages

1. Energy and Water Savings: The resource efficiency provided by green design and technology leads to drastic reductions in operation costs that quickly recoup any additional project costs and continue to offer dramatic long-term savings. Money previously directed toward utility costs may be used for other purposes.

2. Increased Property Values: With energy costs on the rise, the low operating costs and easy maintenance of green buildings make for lower vacancy rates and higher property values.

3. Decreased Infrastructure Strain: Efficient buildings exert less demand on the local power grid and water supply, stretching the capacity of local infrastructure.

4. Improved work Attendance: Green design emphasizes increased natural lighting and control of ventilation and temperature-attributes that improve employee health and prevent absenteeism from work.

5. Increased occupant Productivity: Occupant's productivity has been positively correlated to indoor environmental conditions, and shows improvements where green principles have been applied.

6. Development of Local Talent Pool: With increased attention being paid to global climate change and the need for renewable energy sources, the field of building design and construction is moving toward sustainability as a permanent objective. Building green is an investment in the local economy, helping to foster a local talent pool: designers and builders experienced with green projects able to accommodate the growing market demand for sustainable development.

7. Efficient technologies: Green buildings incorporate energy and water efficient technologies that are not as readily available in traditional buildings. These technologies create a healthier and more comfortable environment as they utilize renewable energy, reduce waste, and decrease heating and cooling expenses.

8. Easier maintenance: Green buildings typically involve less maintenance. For example, green buildings generally do not require exterior painting every three to five years: this simple method helps saves the environment, as well as a consumer time and money.

9. Improved indoor air quality: With green buildings, the indoor air quality is improved via natural and healthy materials: green buildings utilize clean energy sources such as solar and wind power, rather than burning coal.

10. Return on investment: Considering the average lifecycle of a building (50-100 years), certain green building measures, such as installing solar panels or doubling the amount of installation, can yield a strong return on investment and lead to higher resale values.

11. Tax incentives: Incentives exist on a local, state, and federal level to support building green initiatives.

Social Benefits

1. Improved Health. Poor indoor environmental quality (IEQ) resulting from insufficient air circulation, poor lighting, mold build up, temperature variances, carpeting and furniture materials, pesticides, toxic adhesives and paints, and high concentration of pollutants (typically 10 to 100 times higher than outdoors contribute widely to respiratory problems, allergies, nausea, headaches, and skin rashes). Green building emphasizes ventilation and non-toxic, low emitting materials that create healthier and more comfortable living and working environments.

2. Healthier Lifestyles and Recreation. A key element of sustainable design is the preservation of natural environments, which afford a variety of recreation and exercise opportunities. Green buildings also seek to facilitate alternatives to driving, such as bicycling and public transport, which eases local traffic while encouraging personal health and fitness.

Conclusion

Eco-friendly buildings were made up of green materials and these will beneficial for environment, Reduces different pollutions. Major special functions of green buildings are 3Rs (Reduce, Reuse, and Recycle).

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Importance of Drip Irrigation in Vegetable Crops

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Shankar Lal Bijarnia[1], Harish Kumar Bijarnia[2]
[1]Research Scholar, Department of Soil Science & Agricultural Chemistry, SKRAU, Bikaner, Rajasthan 334006.
[2]Research Scholar, Department of Agronomy, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan 313001.

Introduction

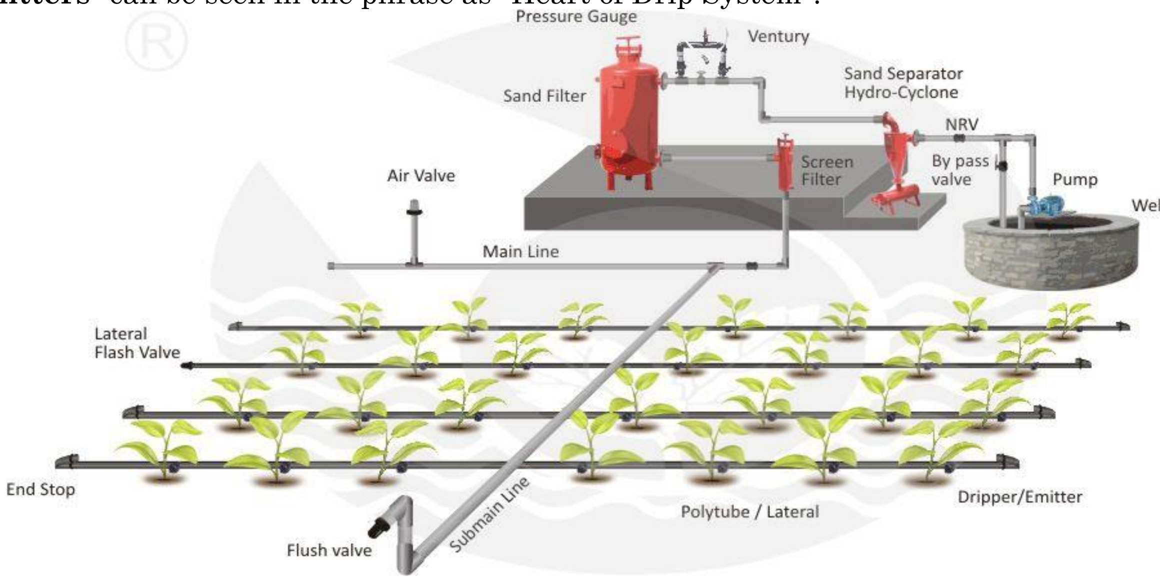
In the current era of scarcity of water resources, drip irrigation seems to be a viable option to irrigate crops, especially horticultural ones, which releases water at very low and precise rates. At the same time, it's more important role can be seen in light textured soils where permeability rates are very high and therefore, other methods of surface irrigation appear to be inefficient. The drip or trickle irrigation system was first developed by Symcha Blass in Israel. Drip irrigation is a micro irrigation method in which the rate of water application is very low and precise. Drip irrigation is based on the basic concept of irrigating only the root zone of crops, rather than the entire land surface on which the crop is growing. The soil moisture content of the crop root zone is maintained at near optimum level to facilitate optimum crop growth and production.

Scenario of Micro Irrigation

At current scenario, the total area under micro irrigation is 10.25 million hectares (mha). Out of this 10.25 mha, 4.77 mha is under drip irrigation and remaining 5.48 mha under sprinkler. Among states of India, Rajasthan covers maximum area under micro irrigation (1.83 mha) followed by Andhra Pradesh (1.58 mha) and Maharashtra (1.54 mha). (Agriculture Statistics at a glance - 2018).

Principles of Micro Irrigation

The basic principle of the system is to apply water in precise rates directly to the root zone. System operates at low pressure through the various components say mains, sub-mains, laterals and emitters. Importance of the "**emitters**" can be seen in the phrase as "Heart of Drip System".



Advantages of Drip Irrigation

Drip method of irrigation has many advantages but the highly efficient use of water seems to be most important (with irrigation efficiency of 80-90% in contrast to only 30-50% in flooding) among all. Besides, even saline water can be used in trickle irrigation method which is a limitation in flooding. Also, it saves water up to 40 to 100% and can apply fertilizers efficiently. Besides these, drip irrigation system also has other advantages as listed below.

1. Water logging is avoided.
2. Over irrigation is avoided.
3. Reduced labor cost.
4. Weed control.
5. Highly uniform distribution of water.
6. No soil erosion.
7. Suitable for any topography.
8. Maintenance of high surface temperature.
9. Tolerance to windy atmospheric condition.
10. Less requirement of irrigation water.

Disadvantages of Drip Irrigation

High cost: Drip irrigation systems are expensive due to requirements of large quantity of piping & filtration equipment to clean the water.

Management: Drip irrigation systems normally have greater maintenance requirements because soil particles, algae, or mineral precipitates can clog the emission devices.

Clogging: If the water is not properly filtered and the equipment not properly maintained, it can result in clogging. Drip tape causes extra cleanup costs after harvest. Need to plan for drip winding, disposal, recycling or reuse.

Potential for damage: Animals, rodents and insects may cause damage to some components. The drip irrigation systems need additional equipment for frost protection.

Comparison Between Different Irrigation Methods

Particulars	Drip method	Flood method	Sprinkler method
Water saving	High (40-100%)	Less.	25-50%
Irrigation efficiency	80 – 90%	30 - 50 %	50-70%
Weed problem	Almost nil	High	More than drip but less than flood method
Diseases and pests	Relatively less	High	Relatively higher than drip but lower than flood method
Water control	Can be regulated easily	Not much control	Can be regulated easily
Yield increase	higher than flood method	Less compared to drip	Higher than drip but lower than flood method

Source: IIVR-2011.

Components and Design of Drip Irrigation System

The basic components of drip system are pumping set, filters, injectors, mainline, sub-mains, laterals, drippers/emitters.

Pumping set: To create a pressure of about 1.0 to 2.5 kg/sq cm to regulate the amount of water supplied.

Disc Filter: To filter the water in order to remove the suspended impurities from water.

Main line: It is a Distribution system in drip irrigation. Rigid PVC and high-density polyethylene pipes are used as main pipes to minimized corrosion and clogging.

Sub Mains: It is usually connected to the main line through a control valve assembly. The function of it is to distribute water uniformly to a number of laterals.

Injector: Injectors allow the introduction of fertilizer, chemicals and maintenance products into the irrigation system.

Drippers/emitters: It is fitted to a drip irrigationlateral and intended to emit water in the form of dropsor continuous flow at emitter rates 1 to 4 liters/hr.

Conclusion

After going through all the details and studies about drip irrigation system, we can come to the following conclusions:

1. Drip irrigation should not only be looked as a water saving tool but as a technology for improvement of vegetable crops yield and its quality, soil productivity and means to generating employment in rural areas. (Aujla *et al.,* 2007).

2. Drip irrigation in capsicum level at 100% Evapotranspiration through drip irrigation with polyethylene mulch gave best result for growth and development characters plant height, fruit weight, fruit length and fruit width. (Rasal *et al.,* 2017).

3. Use of drip irrigation in bitter gourd 100 % ET level with drip irrigation produced superior values for plant height, number of fruits per plants, average fruit weight, fruit length, and yield per hectare. (Rolaniya *et al.,* 2018).

4. Drip irrigation system in onion performed superior over surface irrigation system in terms of superior plant morphology, yield and quality of bulb. Drip irrigation recorded maximum plant height, number of leaves and neck thickness in Rabi seasons. (Gupta, P. 1970).

Future Prospects

1. The current government's manifesto has talk about "**Har Khet Ko Paani**" with Honourable Prime Minister's mantra of "**Per Drop More Crop**". Pradhan Mantri Krishi Sinchayee Yojna (PMKSY) was launched in 2015.
2. With the need to increase productivity while saving water, micro irrigation will play a key role for the future of Indian agriculture.
3. Steps should be taken for large scale adoption of micro-irrigation methods
4. Round the year use of drip irrigation system.
5. Introducing drip irrigation in areas lacking ground water source.

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Block Chain Technology in Agriculture and Supply Chain

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Oviya. M[1], Rohit Sinha Roy[1], Uzma Manzoor[1]
[1]School of Agricultural Sciences, Sharda University, Uttar Pradesh.

Introduction

A block chain is a digital ledger system maintained by a computing machine that are not relying on a trusted third party. Individual data are first managed through software, stored, processed and then turned into human readable format. The information is Stored in block wise manner where every block contains header, transaction data and Link to the previous data. This is how it helps in supply chain management to create a transparency and flexibility among the parties.

Food Supply Chain

Supply chain carried out in post-production that is highly importance which helps the producers to reach products in a right manner and at the right time with proper packaging to consumers. There are different stages

Producer: Information about the farm about the crop cultivation and known about the inter culture practices of their products.

Processing: Information about the equipment, packaging, grading etc.

Distribution: Shipping details, storage facilities, time tracking

Retailers: Detailed information about food items, quality, quantity and self-life.

Consumer: At final stage, the consumer scans the QR code which is associated to items see all the details from producers to the retailers.

In these stages all the information is stored and can be seen by all the members of the particular chain. This mainly creates transparency in financial transactions without any intermediates and very less chance for fraud or commissioned between the parties at different stages. And the consumer is much aware about the products from where its manufacturers, stores, transport etc.

Application of Block Chain Technology in Various Fields

Food security: Presently human population is increasing and its essential to provide a healthy nutritious quality food to the population. Blockchain creates opportunity for disintermediating the process of delivery, making records and to respond rapidly and effectively.

Food safety: Food safety is the condition of processing, managing and storing food in hygienic ways, in order to prevent illnesses from occurring to human population. Blockchain could provide a solution in the urgent need for an improved traceability of food regarding its safety and transparency. recording information about food products at every stage of the supply chain allows to ensure good hygienic conditions, identifying contaminated products, frauds and risks as early as possible

Farms Support System: Even medium-size farmers could benefit from blockchain and the aforementioned initiatives, as they form a clearly different category than the large corporations. Cooperatives, on the other hand, might be formed by either small- or medium-size farmers, and can become quite large entities representing tens or hundreds of farmers. Blockchain could be very useful for such cooperatives, because the transparency of information involved could help to solve disputes and conflicts among the farmers in a fairer way for everyone

Environment awareness: Various waste management initiatives have incorporated blockchain technology. The initiative rewards people who bring plastic rubbish to bank recycling centres, and this reward is provided via blockchain-secured digital tokens. With these tokens, people can purchase things like food or phone-charging units in any store, using the Plastic Bank app. The plastic Bank initiative seems to be successful till date.

Opportunity

1. Traceability in supply chain
2. Support small framers
3. Fairing price along whole chain
4. Increase sustainability
5. Reduce transactional fees
6. Better quality and lower rate of food borne disease.

Challenges

1. Small marginal farmers lack of adoption about technology.
2. Lack of expertise.
3. Awareness is less among the people.
4. Presently it's in adoption stages and takes time for growth stages.
5. Technical issues.

Developed Versus Developing Countries

As seen and discussed about Blockchain requires more technical skills and it's in adoption stages. The developed countries have come across and used successfully with available expertise but developing countries lacks expertise for growers who operates and supports are very much less from the government part.

Conclusion

This article demonstrates that blockchain technology is to establish a proven and trusted environment to build a transparent and more sustainable food production and distribution, integrating key stakeholders into the supply chain. Yet, there are still many issues and challenges that need to be solved, beyond those at technical level. Block chain is a promising technology towards a transparent supply chain of food, but many barriers and challenges still exist, which hinder its wider popularity among farmers and food supply systems. The near future will show if and how these challenges could be addressed by governmental and private efforts, in order to establish blockchain technology a secure, reliable and transparent way to ensure food safety and integrity. It is very interest to see how blockchain will be combined with other emerging technologies towards higher automation of the food supply processes, enhanced with full transparency and traceability.

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Impact of Climate Change on Fruit Crop Production

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Shiv Kumar Ahirwar[1]

[1]Ph.D. Research Scholar, Department of Horticulture (Fruit Science), Jawahar Lal Nehru Krishi Vishwa Vidyalaya, Jabalpur, MP 482004.

Abstract

Climate change effects the fruit production with increase or decrease temperature and the effects of greenhouse gases and production, quality of fresh fruit crops can be directly and indirectly affected elevated levels of carbon dioxide and ozone.

Due to rise in atmospheric CO_2 levels, global climate change and horticultural practices has both effects on secondary metabolite synthesis in plants and also affect post-harvest quality causing sugar content reduction. Temperature increase affects photosynthesis directly, causing alterations in sugars, organic acids, flavonoid contents, firmness, and antioxidant activity. So, we need to develop new cultivation and processing techniques in order to produce sufficient food supplies to meet the basic nutrient requirements of the growing human population.

Introduction

Climate change cause an increase in temperature, variations in rainfall, and an increase heat, cold waves, frost days, droughts, floods, etc. and some process of plants such as vegetative growth, flowering, fruiting and fruit quality are highly vulnerable to climate changes. Two major parameters of climate changes on plants like more erratic rainfall patterns and unpredictable high temperature spells which are reducing crop productivity. Temperature affects photosynthesis and causing alterations in sugars, organic acids, flavonoid contents, firmness, and antioxidant activity. Due some other moisture stress and high temperature during flowering strongly influences the pollen and ovule quality and consequently the fruit set and yield of various fruit crops. Drought reduced fruit set and increased fruit cracking in pomegranate and litchi. In banana crop, stigma and stamen sterility is major problem because of high temperature and it caused the flower drops as well as sex changes in female and hermaphrodite flowers and flower drop is also common in mango, guava, litchi and other fruits, if low temperature prevails during flowering. Higher temperature during fruit growth and development increased the incidence of several physiological disorders like spongy tissue and black tip in mango, cracking of fruits, granulation in citrus, etc.

Impact of Climate Change on Fruit Crop Production

1. Impact on phenology: Phenology is one of the most pronounced effect of climate change like in temperate fruits, flower induction is deeply influenced by temperature, especially low temperature, however, strong interaction between genotype, photoperiod and temperature interactively control flowering. As per study conducted by Wolfe et al., there was an advance in spring phenology ranging from 2 to 8 days for the woody perennials in north-eastern USA during period 1965 to 2001 and a qualitatively consistent and similar phenology shifts with a warming trend have been reported for other mid and highlatitude regions. An earlier date of full bloom of up to 10 days was observed in apple 'Boskoop', 'Cox's Orange Pippin' and 'Golden Delicious' when comparing the last 20 years with the previous 30 years, which is less than the 14 days reported generally for Germany. Advancing trends in bloom dates of many trees indicate that dormancy breaking processes are indeed changing most likely in response to climate change.

2. Impact on patterns of blooming: Vedwan N, Rhoades RE. (2001), climatic changes alter the pattern of blossoming, bearing and, therefore, fruit yield and the quality of apple deterioriate under Western Himalayan condition of India. The greater rise in winter and spring (January to March) temperatures lead to earlier flowering, which coincides with the time of spring frost resulting in a remaining risk of frost damage to apple flowers. In temperate climate areas, frost can also represent the main cause of weather-related damage to crops. Apple and other temperate fruit are vulnerable to spring (late) frosts. During the bloom stage, a single event with temperatures going a few degrees below zero is sufficient to damage flower buds or even kill them. While light frosts result in the deterioration of fruit quality, severe frosts threaten the harvest itself.

3. Impact on dormancy and chilling requirement: The plants use the dormancy mechanism to protect its sensitive tissue from unfavorable climatic condition. Cultivation of many fruit and nut trees requires the fulfillment of a winter chilling requirement and Lack of chilling as in mild winter conditions result in abnormal pattern of bud-break and development in temperate fruit trees. Eventually, warming may affect over-winter chill requirements of temperate tree fruits and require replacement by new cultivars or species. Melting of ice cap in the Himalayan regions will reduce chilling effect required for the flowering of many of the horticultural crops like apple, cherry etc. For cultivars with chilling requirements above 1000 chilling hours such as apples, cherries and pears, very few locations with safe chilling levels were found to exist today.

4. Impact on pollination: The changing climate scenario has contributed in significant reduction in the population of the pollinating insects. If the temperature is either very low or very high there is no fertilization, thus affecting fruit set. For fruits that are cross pollinated such as walnuts and pistachios, insufficient chilling can reduce pollination leading to reduced crop yields. The optimum temperature for pollination and fertilization in temperate fruits like apple, pear, plum, cherry etc. is between 20-25 °C. Low temperatures and rainy or foggy conditions had observed to have a negative effect during pollination in sour cherry in USA.

5. Impact on pest and disease incidence: Climate change could alter stages and rates of development of pathogen, modify host resistance and physiology of host pathogen interactions. Climate change could lead to Changes in geographical distribution, Changes in population growth rates, Increased overwintering, Increase in the number of generations, Extension of developmental seasons, Changes in crop-pest synchrony of phenology, Changes in interspecific interactions of insects and Increased risk of invasion by migrant pests (Parmesan, 2007).

6. Impact on Fruit Quality: The increase in temperature from 0.7-1.0 °C may shift the area suitable presently for the quality production of Dashehari and Alphonso varieties of mango. Rise in temperature by 0.2 °C may result into dramatic reduction areas suitable for development of red colour on guava (Rajan, 2008). Mandarin exposed to direct sunlight (35 °C) is 2.5 times firmer than those on the shaded side (20 °C). Decreased cell wall enzyme activity under higher temperature during growth and development delays ripening.

Approaches to Mitigate Impact of Climate Change

1. Dormancy avoidance to bud burst without requiring chilling temperature
2. Temperate fruit trees need manipulation of the chilling requirement
3. Heat treatment to influencing phonological phases of fruit trees in temperate climates.
4. Evaporative cooling to reducing the bud temperature under mild winter condition and thereby increasing the number of chilling hours required for proper bud burst
5. Breaking rest period by chemical application to alleviate the problem associated with insufficient chilling.
6. Low chill cultivars: Introduction and adaptation of low chilling cultivars of crops like apple, peach, pear and plum in certain areas of lower hills and North Indian plains where they could be grown commercially. The low chill cultivars of some temperate fruits are listed below (Rai et al.).

Conclusion

The climate changes the winter chilling of fruit crops and also affects the other aspects like increase in the incidence of physiological disorders, pollination failure and phenology. Due to rising atmospheric CO2, food production in future is uncertain with global warming and altered precipitation and is limited information regarding of pests and diseases in a hanging climate, which may influence future food security.

Loss in plant diversity and area suitability due to climate change will further increase the problem. Under such threats in global fruit production a plan based on strategic scientific assessment of such impacts should be quantified with adaptation and mitigation.

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Studies of Mulching: A Soil and Moisture Conservation Practices in Dryland Agriculture-Review

Article ID: 35075

Chandan Singh Ahirwar[1]
[1]School of Agriculture, ITM University, Gwalior, Madhya Pradesh-474001.

Abstract

Agricultural water resources have been limited over the years due to global warming and irregular rainfall in the arid and semi-arid regions. To mitigate the water stress in agriculture, mulching has a crucial impact as a water-saving technique in rain-fed crop cultivation. It is important mainly for preserving soil moisture, relegating soil temperature, and limiting soil evaporation, which affects the crop yield. When mulching is applied significantly less irrigation is needed because it reduces evaporation. Drip irrigation is most suitable techniques for crops grown in polyhouse. The EC of irrigation water should be < 1 dS m-1 and pH slightly acidic. The necessity to increase the production of food grains and enhances the quality of surrounding environment has leaded to find the materials to control or regulate the water and wind erosion. Mulching has become now a day's an essential and decisive exercise in agricultural production. It lessens the application of herbicides and various chemical fertilizers control the weeds and maintains the soil moisture and soil temperature. This article consists of the detail reviews of different research conducted on mulches and elaborate the opportunities that they resolving the problem in agriculture. The resources of water for agricultural operations have been inadequate over the years as a result of global warming and uneven or uncertain rainfall in the low rainfall zones of India. To alleviate the water scarcity in agriculture, mulching has a vital impact as a water conserving technique in rain-fed cropping.

Keywords: Mulching, Soil, Moisture, Conservation, Dryland Agriculture.

Introduction

Agriculture is the largest water consumer in the world which accounts for 70% of total use (**Qin et al. 2018**). Among them, 80% of worldwide cropland is covered by rain-fed (non-irrigated) that produces 60–70% of the world's food (**Chen et al. 2018**). Dryland and rainfed agriculture contribute 40% of food grains production and supports half of the human and two-third of the livestock population. This implies that the country will continue to grapple with the problems of rainfed agriculture. Dryland farming is characterized by low crop productivity and high variation in yields from year to year. In dry farming areas, though the total rainfall received is adequate for crop growth, its distribution determines the crop productivity.

The dry spells, due to erratic rainfall distribution, especially at critical stages, affect the yield adversely. In rainfed areas, all the rainfall received is not available for the crops and a significant part is lost as run off. Moisture stress further affect the nutrient availability to the crop since nutrient mobility depends Considering the growing water shortage, rain-fed cultivation plays a prime interest in the worldwide food supply (**Sun et al. 2012; Li et al. 2017**).

India will have to produce 300 million tonnes of food grains to feed her burgeoning population. This target cannot be realized from irrigated areas alone. An appropriate technology has to be evolved for dry land farming. On the other hand, it can be said that second 'green revolution' in Indian agriculture can be had in rainfed/dryland agriculture. This is important to improve the standard of living of farmers residing in these areas as well.

On the other hand, global warming and irregular rainfall patterns are responsible for the shortage of water resources which limit agricultural production in arid and semi-arid regions (**Qin et al. 2015; Li et al. 2017**). Thus, agriculture water management is a major concern to save water in cultivated land. Also, rain-fed cultivation in dryland farming is being pressured which required more effective utilization. What is Mulch? Mulch is any type of soil covering which is spread or laid on top of the soil. It is used primarily to help the health of the soil and the growth of plants, but it can also be used as a decorative feature.

Problems of Dryland and Rainfed Areas

Most of the cropping in the arid and semi-arid regions continues to be under rainfed conditions. Dryland soils are not only thirsty but hungry also. A majority of the farmers are small farmers with meagre resources. The poor resource base permits only low input subsistence farming with low and unstable crop yields. The low productivity of agriculture in dryland farming regions is due to the cumulative effect of many constraints for crop production.

Frequent drought, little or no biomass recycling and low soil organic matter (SOM), multi-nutrient deficiencies, depletion of nutrients by crops, suboptimal nutrient application, low nutrient use efficiency *etc.* are the major constraints in enhancing productivity in the rainfed and dryland areas. Because of the following reasons at present, 3 ha of dryland crop produce cereal grain equivalent to that produced in one ha irrigated crop. The main problem of rainfed areas is uncertainty and uneven distribution of rainfall and loss of water through runoff which leads to low and unstable productivity due to moisture stress at critical stages of crop growth.

It is well known fact that about 85 per cent of annual rainfall is received during south-west monsoon season. In this period knowledge of crop growth phases and moisture availability is more essential because the deficiency of rain water at any critical growth stage may affect the plant growth and yield. Moisture stress further affect the nutrient availability to the crop since nutrient mobility depends on optimum soil moisture.

Moisture Conservation Practices for Rainfed and Dryland Areas

The productivity of grains already showed a plateau in irrigated agriculture due to problems related to nutrient exhaustion, salinity build up and raising water table. Therefore, the challenges of the present millennium would be to produce more from dryland while ensuring conservation of existing resources, the soil and water.

Hence, new strategies would have to be used which would conserve the water and the fragile soil of dryland ecosystems. There are several alternatives for crop burning using on-farm machines for managing of crop residues. These machines perform baling and removing of straw, shredding and surface retention or mulching, shredding and incorporation and resource conservation technologies like no-tillage seeding.

Type of Mulching: for Soil and Moisture Conservation in Dryland Agriculture

Soil Structure Improvement Organic mulches as well as bio-degradable plastic mulches ultimately collapse and augment nutrients to the soil surface, improvement in moisture retention capacity and increment in the humus layer. Soil Temperature Stabilization The fluctuation in temperature is governed by mulches in the plant's root zone, which resulted in the cooler soil in summer and warmer soil in winter season.

Organic Mulches

Organic mulch material includes grass, straw, dry leaves, bark, saw dust and compost. These has capacity to easy degradable due to attract of insects, slugs and cutworms that eat them and it will help to degraded rapidly and it add some amount of organic matter and nutrient in soil. The example of organic mulches and their uses are given below:

Grass Clipping: This is one of the most abundantly and easily available mulch materials across the country. If incorporated fresh in soil, it added some amount of nitrogen to the soil.

Straw: Paddy and wheat straw and other crop residues like stubbles, groundnut shells, cotton shells etc; are the commonest mulching materials used as mulches on soil surface for moisture conservation. Though straw is poor in nutrient value but after decomposition, it makes soil more fertile. Straw mulches reduce both the amount of energy absorbed by the soil and its movement above the soil and hence reduce evaporation.

Newspaper: Newspaper mulching helps to control weeds and also add little organic matter in soil. One to two cm thick sheet of newspaper should be used and edges should be fastened with materials like pebbles gravels etc. The application of newspaper mulch should be avoided on a windy day and avoid the color ink newspaper because it will hazardous.

Dry leaves: Leaves, an easily and abundantly available material, are good for mulching. Though leaves are good for protecting dormant plants during winter by keeping them warm and it help to initiate germination during cold season but dry but due to light weight they may be blown away even by light wind. To reduce these problems to used stone, bark or any other material that help to reduce wind problem.

Bark clippings: These are good mulch materials as they are long lasting and allow proper aeration to the soil underneath. Wood bark has capacity to hold more water and bark mulch material is used in both the region very dry and very wet because if rain is too much the bark will absorb excess water and reduce waterlogged condition. When it rains too little, the wood chips will release the water they've been holding, providing your plants with water even in dry times. Hardwood bark clippings contain more nutrients than soft wood but bark clippings are not easily and abundantly available, and some bark products may cause phytotoxicity.

Saw dust: Saw dust, obtained during finishing operation of wood and furniture is very poor in nutritive value as it contains only half the nutrients of straw. It decomposes slowly. Being acidic in nature, it should not be used in acidic soils.

Compost: The compost is one of the best mulch materials. It increases microbial population, improves the soil health and adds some amount of nutrients. Compost tends to be slightly acidic, so it's an especially great addition to a soil with alkaline nature. However, compost has one drawback. It is very fine and full of nutrients, so it doesn't have much weed-suppressing capability.

Inorganic Mulch Material

Gravel, Pebbles and Crushed stones: These materials are used successful for dryland fruit crops. Small rock or stone layer of 3-4 cm place on soil surface to provides good weed control, reduced evaporation and facilitate infiltration of rain water into the soil. But they reflect solar radiation and can create a very hot soil environment during summer.

Plastic mulch: Plastic mulches are very effective as mulches for evaporation controls provided cost is not limiting factors. Both, black and transparent films are generally used for mulching. Advancement in plastic chemistry has resulted in development of films with optical properties that are ideal for a specific crop in a given location (**Steinmetz *et al.*, 2016**).

These are three types:
Farm Plastic Supply offers one of most effective and economical ways to increase your crop yields with our plastic mulch films. This technique not only suppresses weeds around your crop it also creates a greenhouse effect, warming the soil underneath as well as retains moisture. This agricultural plastic mulch film enables growers to start their season early and effectively increase yields. Other benefits include, cleaner crops because they avoid direct contact with the soil as well as less rotting as a result of mud splashing.

We currently offer the following black and white plastic mulch film options:

a. mil Black.
b. 1.25 mil Black.
c. 2.0 mil White/Black.
d. 1.5 mil Black.
e. 4 mil Black.

Photo-degradable plastic mulch: This type of plastic mulch material is easily destroyed by sun light in a shorter period.

Bio-degradable plastic mulch: This type of plastic mulch film is easily degraded in the soil over a period of time.

Color of film: Films are available in variety of colors including black, transparent, white, silver etc. But the selection of the color of plastic mulch film depends on specific targets. Generally, the following types of plastic mulch films are used in horticultural crops.

Black plastic film: It helps in conserving moisture, controlling weed and reducing outgoing radiation. Standard black plastic mulch film used in agriculture and arboriculture to eliminate weeds, warm up the soil, protect against erosion, and avoid fruits and vegetables from being in direct contact with the soil.

Reflective silver film: It generally maintains the root-zone temperature cooler.

Transparent film: It increases the soil temperature and preferably used for solarization.

Advantages of Mulch on Soil and Moisture Conservation

1. Mulching will reduce the soil erosion
2. Improves the soil structure
3. Regulates the soil temperature
4. Reduce the evaporation losses from soil
5. Effectively controls the weed growth
6. Improves the soil organic matter
7. In dryland area soil salinization avoided.

Other Benefits of Mulching

Prevent weeds from developing: Mulch will not completely eliminate weeds, but it can dramatically reduce the amount that appears, saving you the time and frustration of weeding in the future. Weed seeds need light and moisture to germinate, just like other plants, and mulch can inhibit their growth by denying them of these vital elements. Thick layers of mulch will also prevent a barrier, so most weed seeds cannot reach your soil to take hold.

Increase pest resistance: Some mulches provide an attractive home for beneficial insects and other creatures, which work as a natural pesticide to keep pest problems under control.

Reduce watering: Mulch helps to conserve water by reducing the evaporation of moisture in the soil. This means you will need to water less often, potentially reducing water costs and increasing your plants' resistance to drought.

Improve Soil Quality

Organic mulches release nutrients into the soil as they break down over time, which improves soil quality.
Tidy up borders: Many mulches have a decorative look that helps to tidy up the look of your beds and borders, giving them a uniform and professional style.

Retain soil warmth: Mulch helps to insulate the soil, preventing heat loss and thereby retaining warmth in the soil. This is helpful for plants that are sensitive to sudden drops in temperature, or those who grow best in warm and cozy conditions.

Protect roots from extreme temperatures: As well as retaining heat in winter, mulch also helps to keep the soil cool in the summer. It acts as a temperature leveler, preventing soil from reaching extreme temperatures, and therefore protecting roots from potential damage.

Conclusion

Mulch is any covering material including either organic or inorganic applied on the soil surface to reduce evaporation losses. This material may be grown and maintained in place, or any material grown and modified before placement or any material processed or manufactured and transported before placement. Water is the key input for crop production in rainfed and dryland areas, therefore there is need to adopt a comprehensive approach to conserve soil moisture. Selection of suitable crops and their varieties is most important for rainfed and dryland areas. Planting of crops by altering land configuration viz. ridges and furrows, BBF, FIRB and bed planting are better for higher water productivity in both rainfed and dryland areas.

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Pest Risk Analysis

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Rahul Singh Raghuvanshi[1]

[1]Ph.D. Scholar, Department Plant Pathology, ANDUAT, Kumarganj, Ayodhya, 224229 (U.P.) India,
Sakshi Pandey (M.Sc. (Ag), Department Plant Pathology.

Abstract

A pest risk analysis curve on a graph depicts 1) the notion of pest risk analysis and 2) the interplay of biological, economic, social, and political aspects with quarantine laws, regulations, or decisions. The culmination of these regulatory activities frequently results in a decision on the admissibility of a wide range of imported "items." While the concept applies to both animal and plant quarantine, the focus of this paper is on plant quarantine. Most of the examples presented relate specifically to the pest risk associated with importing plants or plant parts for propagation. Some of the examples presented have wide application in international quarantine circles while others relate only to the United States.

Not just to the commercial, lay, and scientific public, but also to plant quarantine officers, the way of depicting pest risk assessments as a curve should be valuable in efficiently explaining quarantine philosophy, principles, policies, and choices. For within–house quarantine activities, the diagrams may be useful in training, explaining assignments or responsibilities to officers, determining priorities or planning budgets, and as a means for emphasizing the biological aspects of decisions about entry status of imported items.

Introduction

Pest risk analysis (PRA): It is a form of risk analysis conducted by regulatory plant health authorities to identify the appropriate phytosanitary measures required to protect plant resources against new or emerging pests and regulated pests of plants or plant products. Specifically pest risk analysis is a term used within the International Plant Protection Convention (IPPC) and is defined within the glossary of phytosanitary terms as "the process of evaluating biological or other scientific and economic evidence to determine whether an organism is a pest, whether it should be regulated, and the strength of any phytosanitary measures to be taken against it". In a phytosanitary context, the term plant pest, or simply pest, refers to any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products and includes plant pathogenic bacteria, fungi, fungus-like organisms, viruses Pest and virus like organisms, as well as insects, mites, nematodes and weeds.

Pest risk analysis and the international plant protection convention: Introduced plant pests can reduce crop production and have negative consequences for the environment. Plant pests spreading from one geographical location to another is a major worry across the world. The International Plant Protection Convention, a multilateral treaty for international cooperation in plant protection aimed at preventing the spread of pests of plants and plant products, and promoting appropriate measures for their control, is the most important international agreement aimed at addressing the spread of plant pests through international trade. In accordance with the WTO Sanitary and Phytosanitary Agreement the IPPC aims to protect plants while limiting interference with international trade. A key principle of the IPPC is that contracting parties (signatories) provide 'technical justification' to support phytosanitary decision-making affecting trade. The IPPC recognises pest risk analysis as the appropriate format for such technical justification. The responsibility for conducting pest risk analysis sits within government, specifically within a country's National Plant Protection Organization (NPPO) and comes as an obligation when countries become contracting parties to the IPPC.

IPPC standards, referred to as International Standards for Phytosanitary Measures (ISPM), have been developed to assist NPPOs. The primary ISPMs relevant to pest risk analysis are ISPM 2, Framework for pest risk analysis, ISPM 11, Pest risk analysis for quarantine pests and ISPM 21, Pest risk analysis for regulated non-quarantine pests. Although ISPMs relating to pest risk analysis provide guidance regarding the factors to consider when conducting analyses, they do not provide instructions as to how to actually perform a pest risk analysis. However, many countries including Australia, New Zealand and the USA, have developed procedures to assess the pest risks associated with the import of plant commodities. Devorshak (2012) describes the principles of pest risk analysis, how analyses can be performed and the use of pest risk analysis in regulatory plant protection. A general guide to the principles of pest risk analysis for plant pests and a description of some of the problems and difficulties that may be encountered when undertaking such analyses are included in text by Ebbels (2003) which also covers wider plant health issues.

Stages Within a Pest Risk Analysis

In accordance with ISPM, a pest risk analysis consists of three stages.
Stage 1: initiation.
Stage 2: pest risk assessment.
Stage 3: pest risk management.

Stage 1: Initiation

Common reasons for initiating a pest risk analysis include:

- Pest-based information, e.g., a pest is detected during inspection of an imported commodity a pest is reported to be spreading a pest outbreak is detected a new pest is reported in scientific literature.
- Pathway-based information, e.g., a mechanism potentially facilitating the entry or spread of a pest is identified. Mechanisms include new trade pathways, usually of plants or plant products but could also include articles used in the transport and distribution of traded goods such as pests carried as contaminants of passenger baggage and natural spread.
- Review of existing phytosanitary policy, e.g., new information that impacts on an earlier phytosanitary decision can cause a review of policy as can disputes over phytosanitary measures.

Within the initiation stage of a pest risk analysis the reason for conducting the analysis, the identity of the pest and or pathways being analyzed and the area in relation to which the analysis is conducted (the pest risk analysis area) is provided.

The aim of the initiation stage is to identify the pest(s) and pathways which are of quarantine concern and should be considered for risk analysis in relation to the identified PRA area.

1.1 Initiation points

The PRA process may be initiated as a result of:

- ➢ The identification of a pathway that presents a potential pest hazard.
- ➢ The identification of a pest that may require phytosanitary measures.
- ➢ The review or revision of phytosanitary policies and priorities.

The initiation points frequently refer to "pests". The IPPC defines a pest as "any species, strain or biotype of plant, animal, or pathogenic agent, injurious to plants or plant products." In applying these initiation points to the specific case of plants as pests, it is important to note that the plants concerned should satisfy this definition. Pests directly affecting plants satisfy this definition. In addition, many organisms indirectly affecting plants also satisfy this definition (such as weeds/invasive plants). The fact that they are injurious to plants can be based on evidence obtained in an area where they occur. In the case of organisms where there is insufficient evidence that they affect plants indirectly, it may nevertheless be appropriate to assess on the basis of available pertinent information, whether they are potentially injurious in the PRA area by using a clearly documented, consistently applied and transparent system. This is particularly important for plant species or cultivars that are imported for planting.

1.1.1 PRA initiated by the identification of a pathway: The need for a new or revised PRA of a specific pathway may arise in the following situations:

- ➢ International trade is initiated in a commodity not previously imported into the country (usually a plant or plant product, including genetically altered plants) or a commodity from a new area or new country of origin
- ➢ New plant species are imported for selection and scientific research purposes.
- ➢ A pathway other than commodity import is identified (natural spread, packing material, mail, garbage, passenger baggage, etc.).

A list of pests likely to be associated with the pathway (e.g., carried by the commodity) may be generated by any combination of official sources, databases, scientific and other literature, or expert consultation. It is preferable to prioritize the listing, based on expert judgement on pest distribution and types of pests. If no potential quarantine pests are identified as likely to follow the pathway, the PRA may stop at this point.

1.1.2 PRA initiated by the identification of a pest: A requirement for a new or revised PRA on a specific pest may arise in the following situations:

- an emergency arises on discovery of an established infestation or an outbreak of a new pest within a PRA area.
- an emergency arises on interception of a new pest on an imported commodity.
- a new pest risk is identified by scientific research.
- a pest is introduced into an area.
- a pest is reported to be more damaging in an area other than in its area of origin.
- a pest is repeatedly intercepted.
- a request is made to import an organism.
- an organism is identified as a vector for other pests.
- an organism is genetically altered in a way which clearly identifies its potential as a plant pest.

1.1.3 PRA initiated by the review or revision of a policy

A requirement for a new or revised PRA originating from policy concerns will most frequently arise in the following situations:

- a national decision is taken to review phytosanitary regulations, requirements or operations.
- a proposal made by another country or by an international organization (RPPO, FAO) is reviewed.
- a new treatment or loss of a treatment system, a new process, or new information impacts on an earlier decision.
- a dispute arises on phytosanitary measures.
- the phytosanitary situation in a country change, a new country is created, or political boundaries have changed.

1.2 Identification of PRA area: The PRA area should be defined as precisely as possible in order to identify the area for which information is needed.

1.3 Information: Information gathering is an essential element of all stages of PRA. It is important at the initiation stage in order to clarify the identity of the pest(s), its/their present distribution and association with host plants, commodities, etc. Other information will be gathered as required to reach necessary decisions as the PRA continues.

Information for PRA may come from a variety of sources. The provision of official information regarding pest status is an obligation under the IPPC (Art. VIII.1c) facilitated by official contact points (Art. VIII.2).

For environmental risks, the variety of sources of information will generally be wider than traditionally used by NPPOs. Broader inputs may be required. These sources may include environmental impact assessments, but it should be recognized that such assessments usually do not have the same purpose as PRA and cannot substitute for PRA.

1.3.1 Previous PRA: A check should also be made as to whether pathways, pests or policies have already been subjected to the PRA process, either nationally or internationally. If a PRA exists, its validity should be checked as circumstances and information may have changed. The possibility of using a PRA from a similar pathway or pest, that may partly or entirely replace the need for a new PRA, should also be investigated.

1.4 Conclusion of initiation: At the end of Stage 1, the initiation point, the pests and pathways of concern and the PRA area will have been identified. Relevant information has been collected and pests have been identified as possible candidates for phytosanitary measures, either individually or in association with a pathway.

Stage 2: Pest Risk Assessment

The process for pest risk assessment can be broadly divided into three interrelated steps:

- Pest categorization

- assessment of the probability of introduction and spread
- assessment of potential economic consequences (including environmental impacts).

In most cases, these steps will be applied sequentially in a PRA but it is not essential to follow a particular sequence. Pest risk assessment needs to be only as complex as is technically justified by the circumstances. This standard allows a specific PRA to be judged against the principles of necessity, minimal impact, transparency, equivalence, risk analysis, managed risk and non-discrimination set out in ISPM No. 1: *Principles of plant quarantine as related to international trade* (FAO, 1995).

There are three steps to the assessment of pest risk.

- **Step 1: Pest categorization**

The purpose of pest categorization is to determine whether a pest identified during the initiation stage satisfies the criteria of being a quarantine pest. A quarantine pest is a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled. Pest categorization includes all the main elements considered in Step 2 of a pest risk assessment but the elements are considered in less detail and pest categorization is essentially a quick assessment of whether the analysis should continue. The categorization step provides an opportunity to eliminate a pest from analysis at an early stage in the pest risk analysis process thus avoiding unnecessary in-depth examination. Pest categorization can be done with relatively little information, provided that the information available is sufficient to carry out the categorization.

Conclusion of pest categorization

If it has been determined that the pest has the potential to be a quarantine pest, the PRA process should continue. If a pest does not fulfil all of the criteria for a quarantine pest, the PRA process for that pest may stop. In the absence of sufficient information, the uncertainties should be identified and the PRA process should continue.

- **Step 2: Assessment of pest entry, establishment and spread.**

Assessing the likelihood of pest entry requires assessment of each of the pathways with which a pest may be associated, from its origin to its establishment in the pest risk analysis area. In a pest risk analysis initiated by a specific pathway, often an imported commodity or goods associated with an imported commodity, e.g., packing materials, the probability of pest entry is evaluated for that specific pathway. For a pest risk analysis initiated for a specific pest, all probable pathways are evaluated for that individual pest.

To estimate the likelihood of establishment of a pest, biological information about the pest including its life cycle, its hosts or habitat needs, or a diseases epidemiology, together with characteristics of the abiotic environment affecting pest survival such as temperature, precipitation and perhaps soil type affecting its geographic range limit need to be considered. The environmental conditions under which the pest does not survive are also important to understand. Conditions in the pest risk analysis area can then be compared with conditions in areas where the pest survives, and in areas where the pest is known not to be able to survive, so as to assess the likelihood that the pest will establish in the pest risk analysis area. Computer simulation models can be used to inform assessments of likelihood of establishment.

When assessing the likelihood and magnitude of pest spread, the pest's ability to disperse from a point of introduction to new areas within the pest risk analysis area is assessed. The assessment should consider pest population dynamics and the natural mobility of the pest and take into account potential spread via wind, water, soil, seed and pollen, and insect, fungal or nematode vectors as well as spread via human activities such as movement of host material.

- **Step 3: Assessment of potential consequences resulting from pest entry, establishment and spread.**

In this step the potential impacts that could be expected to result from a pest's introduction and spread is identified, described and, as much as possible, quantified. Pest impacts can take many forms; they may be economic environmental or social impacts. Information on the species impacts in areas where it is already present, and particularly in areas where it has already spread to, together with information influencing the elements of risk in the pest risk analysis area, inform the assessment of potential consequences.

Impacts reported from invaded areas are recognized as the best indicator of potential impacts in the pest risk analysis area.

However, regarding environmental impacts, if the pest has not previously spread then the absence of any environmental impact in the area of pest origin should not be interpreted to mean that no environmental impact should be expected in the pest risk analysis area. This is because environmental impacts are difficult to predict and a lack of impact in the origin is not a good predictor that there will be no impacts in regions where a pest is introduced.

Recognizing that risk is a combination of likelihood and consequences, the results of steps 2 and 3 are combined to provide an overall estimation of pest risk.

Stage 3: Pest Risk Management

For a quarantine pest, pest risk management is the process of evaluation and selection of options to reduce the risk of introduction and spread of the pest. Conclusions from the pest risk assessment (Stage 2) are used to support decisions regarding the level of risk presented by the pest. If a pest is judged to present an unacceptable risk, then phytosanitary measures should be identified that will reduce the risk to an acceptable level. Phytosanitary measures should accord with IPPC principles of necessity, managed risk, minimal impact, transparency, harmonization, non-discrimination and technical justification.

ISPM provides more information about each stage of pest risk analysis for quarantine pests.

Level of Detail Required

The level of detail in a pest risk analysis will be limited by the amount and quality of information available, the tools, and time available before a decision is required. Quantitative and qualitative techniques are used in pest risk analysis but pest risk analysis need only be as complex as is required by the circumstances to support a phytosanitary decision and provide the necessary technical justification to defend decisions regarding phytosanitary measures. Nevertheless, a pest risk analysis should be based on sound science, be transparent and consistent with other pest risk analyses conducted by the NPPO. Examples of pest risk analysis are available in the EPPO Platform on PRA.

Uncertainty

Estimating the likelihood of pest introduction and of the consequences that could result involves many uncertainties. Uncertainty is always part of pest risk analysis very often there is a lack of data necessary to reach secure conclusions. The subjective nature of pest risk analysis is also a source of uncertainty. ISPM 11 recognizes that pest risk analysis involves many uncertainties, largely since estimates and extrapolations are made from real situations where the pest occurs to a hypothetical situation in the pest risk analysis area. In most cases analyses performed during pest risk analysis use historical data to forecast potential future events. It is important to document the areas of uncertainty and the degree of uncertainty in the assessment, and to indicate where expert judgement has been used. This is necessary for transparency and may also be useful for identifying and prioritizing research needs.

Criticism of Pest Risk Analysis

Pest risk analysis, as conducted under the IPPC and SPS Agreement, has been criticised for being reactive, only coming into effect after a pest problem has been identified. For example, many pests now subject to phytosanitary measures, supported by pest risk analysis, only became recognised as potential risks once they had already escaped from their geographical centres of origin and caused impacts in other parts of the world. Some 'newly escaped' organisms were previously unknown to science before they escaped and current international standards for pest risk analysis cannot assess risks from unknown organisms. In addition, a pest risk analysis will focus on a pest at the species level assuming the pest to be genetically stable but this can be a great oversimplification if the pest has a short generation time with capacity for rapid genetic change. During the assessment of impact, assessors focus on impacts on known hosts or habitats. However, if a pest adapts to a new host plant or habitat once established in the pest risk analysis area, impacts will be underestimated. Risk analyses for invasive species have also been criticized for being narrowly focused, subjective, often arbitrary and unquantified, and subject to political interference.

Conclusion of Pest Risk Management

The result of the pest risk management procedure will be either that no measures are identified which are considered appropriate or the selection of one or more management options that have been found to lower the risk associated with the pest(s) to an acceptable level. These management options form the basis of phytosanitary regulations or requirements.

The application and maintenance of such regulations is subject to certain obligations, in the case of contracting parties to the IPPC.

Phytosanitary measures taken in relation to environmental hazards should, as appropriate, be notified to relevant competent authorities responsible for national biodiversity policies, strategies and action plans.

It is noted that the communication of risks associated with environmental hazards is of particular importance to promote awareness.

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Capacitance Soil Moisture Sensor: Efficient Irrigation Water Management for Enhancing Agricultural Water Productivity

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Amit Kumar[1], Reena Kumari[2]
[1]Division of Agricultural Engineering, ICAR-IARI, New Delhi-110012.
[2]Department of Post-Harvest Process and Food Engineering, GBPUAT, Pantnagar -263145.

Abstract
Efficient irrigation management has the potential to improve yields, grain quality, conserve water and energy, and reduce nutrient leaching resulting in reduce groundwater pollution. To improve irrigation efficiency, one of the easiest and most effective ways is to used soil moisture sensors in irrigation scheduling. The efficient irrigation management practices based on the monitoring of the soil moisture provide a great benefit to conserve natural resources by the appropriate amount of water applied in the fields. To reducing the underwatering and overwatering of crops, the status of the current moisture level in the soil surrounding the plants is needed. This will allow a farmer to know when to irrigate and how much to irrigate.

Introduction
Agriculture is directly related to water and is a precious natural resource, which is a basic requirement for the development of a country. It is estimated that total water on earth is 1385.5 million km3 (Shiklomanov, 1993), out of which 97.3% is oceanic saltwater. The availability of fresh water constitutes only 2.7% of the total global water resource (Postel et al., 1996). In India, per capita, water availability has decreased from 5177 m3 in 1951 to 1625 m3 in 2011 due to the population increasing from 361 million in 1951 to 1.15 billion in 2011, which is expected to rise to 1.39 billion by 2025 and 1.64 billion by 2050, with an associated decrease in water availability of 1345 m3 in 2025 and 1140 m3 by 2050 (Wani et al., 2012). About 80% of the water (688 BCM) is being diverted for irrigation, which may increase to 910 BCM by 2025 and 1072 BCM by 2050 (Anonymous, 2017). Providing global food security for a population that is expected to reach nine billion by2050, as well as eliminating poverty, are difficult tasks. Increased food production must be achieved with finite water and land resources. Since 1950, the quantity of available water and land has remained constant, but the availability of water and land per capita has increased. With the rise of globalization and urbanization, there is a growing demand for more productive and efficient methods of cultivating crops to feed an expanding population on dwindling acreage (Miller, 2018).

Over-dependence on groundwater beyond sustainable level use has resulted in a significant decline in the groundwater table, especially in northwest India. The unsustainable groundwater use necessitates demand management and supply augmentation measures for improved water use efficiency in the agriculture sector. One of the methods is efficient irrigation management practices for fields. Irrigation water management practices could greatly benefit from the knowledge of moisture in the soil and ultimately increase crop yield, improve the quality of crops, conserve water resources, save energy, and decrease fertilizer supplies.

Soil Moisture Sensor
A soil moisture sensor is used to determine the amount of moisture in the soil. The kind of soil, whether sandy, clay, loam, or sandy loam, and salts contained in the soil, such as iron, manganese, calcium, phosphorus, nitrogen, Sulphur, and others, all influence soil moisture.

Irrigation is carried out based on the moisture sensor's reading. The amount of water in the soil is measured or estimated using soil moisture sensors. These sensors might be fixed or mobile, like handheld probes. Portable soil moisture probes can test soil moisture at many sites, whereas stationary sensors are put at predetermined locations and depths in the field. To efficiently use soil moisture sensors, a greater understanding of the basic ideas, terminology, and terms underpinning the soil-water-plant interaction is required. Based on the methods used to determine soil moisture, soil moisture sensors can be categorized into the following categories. When inserted in the soil profile, 1) sensors that detect volumetric water content and 2) sensors that measure soil tension.

Volumetric Water Content (VWC) Soil Moisture Sensors

The volume of liquid water per volume of soil is referred to as volumetric water content. In most cases, it's given as a percentage. For example, 0.25 cubic centimeters of water per cubic inch of soil is 25% volumetric water content (VWC). Volumetric water content (VWC) measurements can be used to determine soil water deficit for irrigation scheduling when compared to the maximum amount of water that the soil can hold or field capacity:

Soil water depletion/deficit (inches) = soil water content at field capacity (cm) - current soil water content (cm)

Soil Water Deficits and Crop Stress

Understanding the soil water content at which a crop begins to experience stress is critical for irrigation scheduling. Most crops begin to experience stress when soil water depletion/deficiency reaches 50% of available water holding capacity (AWC). This is known as the irrigation trigger point or management allowable depletion (MAD). MAD varies depending on the crop, growth stage, and the pumping capacity of an irrigation system. Irrigation should be initiated when the percent soil water depletion equals or approaches the percent MAD.

Volumetric water content (VWC) can be used to calculate %s soil water depletion using the following formula:

$$\% \text{ Soil Water Depletion} = \left[1 - \left(\frac{Sensor\ VWC\ (\%) - PWP\ (\%)}{FC(\%) - PWP\ (\%)}\right)\right] * 100$$

Where PWP is a permanent wilting point and FC is field capacity.

Soil moisture sensors can be used to easily measure field capacity in the field. The field capacity of the soil is determined by the VWC data produced by the soil moisture sensor after 12-24 hours of heavy irrigation or rain. Growing indicator plants like sunflowers can help determine the PWP.

Soil Water Tension or Matric Potential Sensors

The energy required by plant roots to obtain water from soil particles is measured by soil water tension. Soil tension rises as soil water is withdrawn from the soil. The soil tension is measured in centibars (cb) or air pressure bars. Soil water tension is near zero when the soil is saturated with water. When soil tension is 25-45 cb, AWC is 50% depleted in coarse-textured soils. A crop should be irrigated in these soils before the sensor reads 25-45 cb.

Sensor Installation and Placement

Sensors should be installed at various depths and in the field at various locations. In the case of high points, depression, or slopes, sensors are typically set in pairs at the depth of one-third and two-thirds of the root crop zone and in two or more locations in the field, ideally in the representative soil type. The thumb rules are to be applied to the ground, to 15 cm, 30, 45 cm, to 60 or 15 cm, to 30 cm, and 60 cm. Certain areas are filled with both light and heavy soils. It is advisable to monitor and manage each type of soil individually for irrigation in those areas.

Capacitance Soil Moisture Sensor

A digital soil moisture sensor circulatory system (Figure 1) measures the changes in capacity caused by dielectric variations. It does not directly measure moisture, but measures the ions dissolved in humidity. (Clean water does not conduct electricity well.) These ions may be influenced by numerous variables, such as the use of fertilizers to decrease soil resistivity. The most essential aspect affecting dielectrics is a capacitive measurement of the dielectric forming soil and water. Capacitate measurement offers certain advantages, not only prevents corrosion of the probe but also provides better measurements of ground moisture content than using a resistive ground moisture sensor. Since the soil is not exposed to the contacts (plus plate and minus plate), there is no corrosion of the sensor.

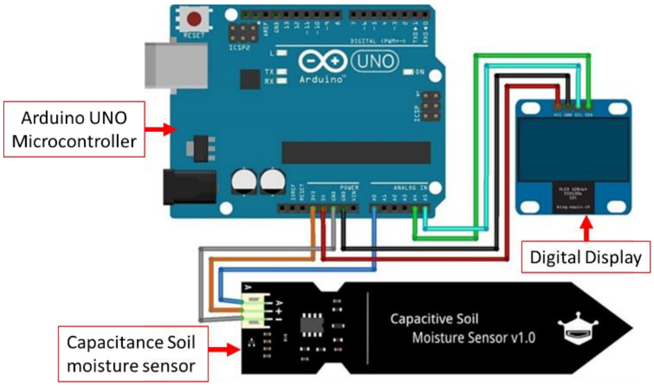

Figure 1: Digital circuit diagram of capacitance soil moisture sensor with microcontroller

Soil moisture monitoring provides easy-to-interpret information helping growers to address the following questions (Zaccaria and Orloff):

1. What is the proper irrigation timing?
2. Has enough water infiltrated the soil during and after irrigation?
3. What is the soil depth reached by irrigation water?
4. Is the water being applied insufficient, enough, or excessive?
5. What is the water depletion pattern by crop roots uptake and soil evaporation?
6. Is there in the soil profile sufficient water to buffer irrigation mistakes?
7. Is there sufficient deep soil water reserve for crop water uptake during periods of no irrigation?

Recommended values of soil moisture content at which irrigation should occur.

Soil Texture	Soil Moisture Content
Sand	7
Loamy sand	12
Sandy loam	15
Loam	20
Silt loam	23
Silty clay loam	28
Clay loam	27
Sandy clay loam	24
Sandy clay	22
Silty clay	30
Clay	31

Adapted from Hanson and Orloff (2002)

The key factors where attention should be focused towards resource-efficient soil-moisture based irrigation practices are reported below:

a. Preliminary evaluation of site-specific conditions.
b. Adequate selection of soil moisture sensors.
c. Proper site selection, sensors installation, and maintenance.
d. The correct interpretation and use of soil moisture data.

Conclusions

Efficient management of the irrigation process could be difficult for farmers as the interaction between soil and water is unknown. Thus, the use of soil moisture sensor monitoring can provide farmers with very useful and economical information to assess their irrigation choices and to improve irrigation procedures, avoid under and over-irrigation which often have a vast number of adverse effects, ranging from loss of yield, water, and energy costs as well as nutrient losses, leach-outs, and environmental problems. In day-to-day irrigation decisions, such information is essential for maximal yields and optimal utilization of water and energy, especially under limits.

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Commercial Use of Aloevera

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Nalinee Sahoo[1], Aradhana Kushwaha[1], Neelma Kunwar[2]
[1]PDF, ICSSR, New Delhi affiliated to CSAU, Kanpur.
[2]Professor, ECM, C.S. Azad University of Agriculture and Technology, Kanpur.

Introduction
Aloevera products are great for commercial use as, aloevera is being used by every second person in the country today. Aloevera benefits health and beauty. That is aloevera products are massively available in the market. Ayurvedic doctors and beauty experts have recommended the use of aloevera products that today every family member whether it is a man or a woman, all are using aloevera products which is promoting its sales commercially.

Composition and Nutritive Value of Aloevera
98.5 per cent water is found in aloevera, along with water- and fat-soluble vitamins and minerals, polysaccharides and organic acids which are considered good for health and beauty. In addition, aloevera's has an extremely great nutritive value with vitamins, enzymes, minerals, sugar and amino acids in it. Due to the high nutritive value, aloevera also helps efficiently in anti-ageing.

Importance of Aloevera
Aloevera is a rich source of antioxidants and vitamins that may help to protect skin. Few important compounds in aloevera have also been known to neutralize the effects of ultraviolet radiation, repair skin from existing ultraviolet damage and help to prevent fine lines and wrinkles.

Health Benefits
1. Aloevera juice is water dense, hence it is an ideal way to prevent or treat dehydration.
2. Juice is an excellent way to keep liver healthy that is because the liver functions best when the body is adequately nourished and hydrated. Juice heals the liver because it's hydrating and helps the skin by providing its phytonutrients.
3. Drinking aloevera juice helps increase the water content in the intestines. Research has shown that the relationship between increasing the intestinal water content and the stimulation of peristalsis, which helps to pass stool normally.
4. Hydrating by drinking aloevera juice may help reduce the frequency and appearance of acne on one's skin. The problem of acne is found more in teenage girls, in which aloevera juice can prove to be helpful as it consists rich sources of antioxidants and vitamins that help to protect the skin and brighten the face.
5. Aloevera juice comprises of ingredients such as calcium, copper, sodium, selenium, magnesium, potassium and zinc etc; which are good for our health and instantly boost the nutrition in the body.
6. Drinking aloevera juice may also give relief while one goes through a heartburn attack. A certain compound present in aloevera juice helps to control secretion of acid in the stomach. Furthermore, also assists in combating gastric ulcers.
7. Aloevera contains several enzymes which are proven to help in the breakdown of sugar and fats providing one with an extremely great and smooth digestion.

Beauty Benefits of Aloevera
1. Aloevera juice is also used in numerous beauty products such as make up primers, makeup removers, sunburn soothers, light weight moisturizers. It is also a component of antiseptics which help in healing wounds, reduce infection and acne.
2. Aloevera cream and gel are proven to lighten and glow one's face when used regularly.
3. Usage of shampoos consisting mainly of aloevera help in hair growth to a great extent. Nowadays, people use synthetic shampoo more, so their hair starts falling thus, to make hair smooth and prevent hair fall they should use aloevera shampoo.

4. Aloevera gel is easily absorbable, making it ideal for oily skin too.

Demand of Aloevera Products in Market

Aloevera products have so many benefits for health and beauty so its demand is increasing day by day in the market. Hence, aloevera is extremely good for commercial purposes as due to its increasing profit is certain.

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Kitchen Garden: A Traditional Concept with Modern Approach

Article ID: 35079

Swapnil Pandey[1], Girja Shanker Tewari[2]
[1]Fruit Scientist, PAU- RRS, Ballowal Saunkhri, SBS Nagar, Punjab- 144521.
[2]Director, Project Sneh, C.L.Gupta Farms, Moradabad, Uttar Pradesh- 244001.

Introduction

In our daily vegetarian diet, vegetables are the major source of vitamins, minerals and fibers. They not only have nutritional benefit but also possess some medicinal attributes in human life (Gautam *et. al.,* 2009). These vegetables provide taste, better digestibility, palatability to us and increase the appetite (Singh *et. al.,* 2018).

According to ICMR, the daily requirement of vegetable per person is around 300 g/ day but the actual availability is very less (Singh *et. al.,* 2018). Thus, growing of vegetables in kitchen garden is now a need rather than hobby.

Kitchen garden or home garden can be explained as "growing of vegetable crops in the residential houses or in their surroundings to meet the vegetable requirements of the family throughout the year".

Scientifically, it is an integrated approach that comprises the family house, a recreational area and a garden in which a variety of food sources including vegetables, fruits and medicinal plants can be grown for one's own consumption (Galhena *et. al.,* 2013). The commercial vegetable growers often use indiscriminate chemical fertilizers to produce insect and disease-free vegetables.

This might lead to serious health hazards causing several impairments to human beings. Because of such situations, maintenance of one's personal kitchen garden for the production of healthy and residue free vegetables proves to be an added benefit. It not only saves the capital and time but also provide a healthy, useful and environment friendly hobby for the whole family. Home gardens also help in recycling of household waste especially the kitchen waste if a compost pit is developed.

This provides organic manure for the vegetables thus giving a natural, non-toxic and a healthy crop. One of the most fundamental determinants of a successful kitchen garden is its location- the place where it has to be established.

In cities, there is hardly any choice left *w.r.t.* size, shape and location. Under such circumstances, wherever space is available it has to be utilized. If the garden is located outside the house a live fence all around be raised to protect the garden.

Principles Considered While Designing a Kitchen Garden

1. Land should be near the house preferably in the backyard.
2. Continuous supply of irrigation water should be there.
3. The garden should never be located in a shady place. It should receive maximum sun light for the most part of day.
4. The layout should be such that all parts of the garden should be accessible.
5. The fruits trees, if present, should be planted on north side of the garden so that they do not provide shade to other crops.
6. The fence should be used as support of climbing types of vegetables such as cucumber, pea etc.
7. To ensure a steady supply of vegetables for a longer period, several sowings or succession of sowings of one particular crop should be done at short intervals.
8. The root vegetables *viz.* carrot, radish, turnip, beet root etc. can be accommodated on the ridges of the beds.
9. The quick growing vegetables such as turnip, radish, leaf beet etc. can be grown in the inter-spaces of slow growing crops such as cauliflower, cabbage, eggplant etc.

Crop Selection Criteria

The crop selection criteria for kitchen garden depend on two factors *i.e.,* size of the garden and choice of the family. The vegetables suited to a particular region giving satisfactory yield are only selected. The crops in which freshness is an important edible trait and maximum food value such as tomato, chilli, beans, pea, salad crops, leafy vegetables etc. are mostly preferred.

A Tentative Monthly Schedule for Kitchen Gardening in North Indian Plains

January: Sowing/ planting of muskmelon, watermelon, coriander, lettuce, spring potato, European radish and late cauliflower.

February: Sowing/ planting cucumber, okra, amaranth, bottle gourd, pumpkin, bitter gourd, summer squash, pointed gourd, European radish, eggplant, tomato and chilli.

March: Repeat the sowing of okra, amaranthus and leaf beet. Sowing of cowpea, cluster bean, round melon (*tinda*) and other above-mentioned crops if not sown earlier.

April: Continue with the crops which were sown in March.

May: Sowing of radish, rainy season okra, bottle gourd, cucumber, bitter gourd and pumpkin.

June: Continue with the crops sown in May and also sow early cauliflower, cowpea, cluster bean, Dolichos bean, round melon, sweet potato and radish.

July: Sowing of early cauliflower, cluster bean, okra, bottle gourd, Dolichos bean, tomato, chilli and brinjal.

August: Planting of carrot, cauliflower, leaf beet, turnip (Asiatic type) and chilli. Also, sowing of cabbage, beetroot, knol-khol, onion bulb sets (*kharif* onion), fenugreek, and coriander.

September: Sowing of early pea, coriander, onion bulb sets (*kharif* onion), radish, carrot, turnip, celery, beetroot, Dolichos bean, cauliflower (late group), cabbage, knol-khol, lettuce, leaf beet, potato and pea.

October: Sowing/ planting of lettuce, potato, turnip, beetroot, radish, pea, French bean, garlic, onion and knol-khol.

November: Sowing of crops mentioned for October along with sowing of pea, tomato and spinach.

December: Sowing of tomato, spinach, late cauliflower and pea, if not planted already.

Model of Vegetable Nutrition Garden

The 'Vegetable Nutrition Garden' suggested here has several modifications over the conventional Kitchen Garden (Fig. 1). The proposed new model can be easily fit in urban and peri-urban households where space availability is a limited factor.

The sequence of crops is selected in such a way that the garden remains occupied throughout the year. The crops and their respective varieties are scientifically selected for their high nutritive content with least disease and pest problems, thus restricting the use of pesticides. According to the following plan, upto three annual vegetables can be grown on the same piece of land per year.

Layout and planning of 6 × 6 m Vegetable Nutrition Garden model produces about 300 kg of vegetables annually, enough to meet dietary allowance of an average sized family consisting of two adults and two children (Dhaliwal *et. al.,* 2020).

Conclusion

Despite having good amount of vegetable production at national level, the per capita availability of vegetables is still less from the recommended dietary allowances. Kitchen gardens present a promising opportunity in order to ensure the daily supply of fresh vegetables rich in micronutrients and to address food insecurity and malnutrition issues.

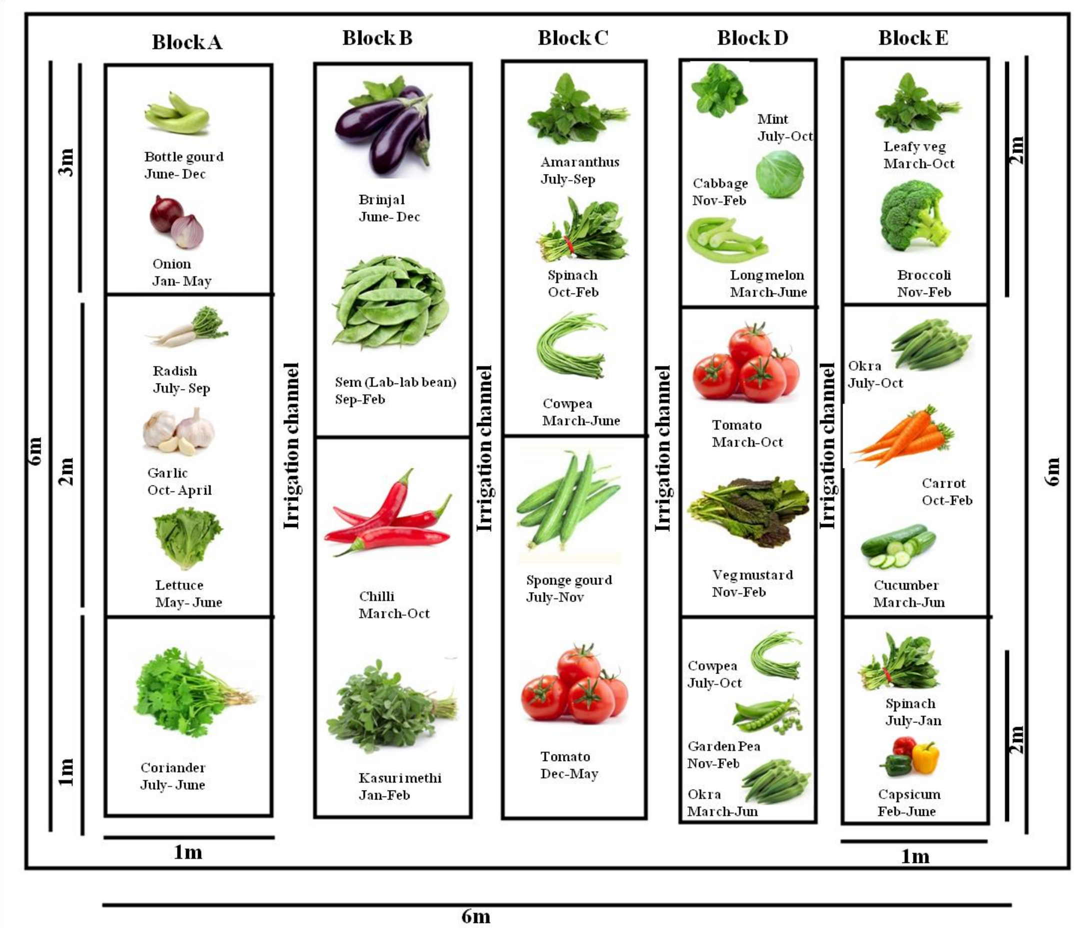

Figure 1: Layout and planning of 6 × 6 m Vegetable Nutrition Garden

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Sheep Associated Malignant Catarrhal Fever in Cattle

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Malik Raies Ul Islam[1], Ishtiyak A Mir[2], Ajaz A Ganie[3], Manzoor Ahmad Yatoo[4]
[1]Krishi Vigyan Kendra Pulwama, [2]Krishi Vigyan Kendra Anantnag, [3]Scientist Krishi Vigyan Kendra Srinagar, [4]FOA Wadoora SKUAST Kashmir.

Introduction

Malignant Catarrhal Fever (MCF), a fatal disease of bovids, cervids and other ungulates, is caused by viruses belonging to family *herpesviridae*. Among the known MCF viruses to cause disease, alcelaphine herpes virus 1 (AlHV-1) and ovine herpes virus 2 (OvHV-2) are widely prevalent. AlHV-1, which naturally infects wildebeest, is responsible for causing the disease in cattle, called wildebeest associated MCF (WA-MCF) and is prevalent in African region. The OvHV-2 is responsible for casing sheep associated MCF (SA-MCF) in cattle and is prevalent in most parts of the world including India. The disease is characterized by Fever, anorexia, corneal opacity, oculo-nasal discharge, dyspnoea, diarrhea, in-coordination, muscle tremors, head pressing, prostration and death. Outbreak of MCF is sporadic in nature and mostly involves only singleton case and in rear situation a few animals may get affected. The sporadic pattern observed in MCF is due to the fact that only the natural host sheep and Wilde beast are able to shed the virus, in their secretions and act as a carrier for susceptible animals. Moreover, cattle or other hosts, which are clinically affected don't excrete the virus and are considered dead end hosts for this infection. The reason being that in most of the susceptible host species, the virus remains cell associated and cell free virus is not produced. Mixed farming of sheep or goat with cattle plays a crucial role in dissemination of this virus to susceptible animals.

Under Kashmir conditions, it is a common practice to co-house cattle and sheep without any barrier of sufficient thickness to prevent the spread of this deadly infection. Such conditions provide an ideal ground for the virus to get transmitted from carrier to the susceptible host. This co-housing of sheep and cattle spans over autumn and winter months and for the rest of the seasons, the sheep are moved to highland pastures. As a result, outbreaks of SA-MCF tend to cluster towards these two seasons. Though most of the livestock owners are becoming aware of the negative impact of co-housing sheep and cattle together, yet most of the outbreaks are as a result of direct contact between the two species.

Host Range

Sheep are the primary hosts of this virus and at the same time act as its carrier and develop only a mild form of MCF in rare cases. Susceptible species like cattle, buffalo, banteng, bison, antelopes and pigs are accidentally involved. Bali cattle are extremely susceptible to OvHV-2 infection followed by more susceptible deer, bison and water buffalo and relatively resistant taurine and zebu cattle.

Transmission of the Infection

The virus is transmitted mainly by respiratory route through aerosols. For virus to get transferred close contact of sheep with susceptible host are needed, however in rare cases transmission of OvHV-2 virus from sheep to cattle separated by 70 meters and bison by up to 5 Km has also been reported. Most of the lambs by the age of 6 to 9 months shed the virus in nasal and ocular secretions. Though some lambs may become infected in utero, however most of them acquire it peri-natally and a very few may acquire after three months of age, probably due to interference from maternal antibodies. Adult sheep may acquire infection horizontally through direct contact with infected ones and shed large quantities of virus intermittently through nasal secretions.

Clinical Signs

In extremely susceptible species that disease can run a per-acute course, with appearance of a few clinical signs before death. The disease in cattle is characterized by Fever, anorexia, drop in milk production and dyspnoea. Muzzle and nares become encrusted. Frothy and copious salivation (fig 2). Diarrhea, hemorrhagic gastro-enteritis and haematuria may also be seen. Bilateral corneal opacity which usually starts at corneo-scleral junction (fig 1), oculo-nasal discharge, which is serous at the beginning and later on becomes muco-purulent. superficial lymph nodes especially pre-scapular and pre-femoral are enlarged. Neurological signs like in-coordination, muscle tremors, head pressing and prostration (fig 2) are apparent in terminal stages. Occasionally the animal may recover from MCF but death is inevitable in all clinical cases.

Treatment

There is no specific antiviral treatment available. Antibiotics and supportive therapy may be given to lessen the severity of clinical signs especially neurological ones and to prevent secondary bacterial complication, but death is inevitable in all clinical cases.

Prevention

Sporadic occurrence of the outbreak, transmission of virus to susceptible animals within the proximity of carrier host and susceptible species being dead end host make it quite easy to contain and prevent the spread of this infectious agent by separation of the carrier species from susceptible ones. Mixed farming of the two should never be practiced. The separation distance between the two needed to prevent the air borne spread, though is not certain, however it is influenced by host, environmental and agent factors. Adopt good husbandry practices, dispose of dead animals and their bedding and disinfect the premises and prevent the mixing of carrier and susceptible species. Don't graze cattle on pastures where sheep have browsed or given birth.

	
Fig 1: corneal Opacity	**Fig 2: dead heifer lying in pool of frothy saliva. In the backdrop sheep co-housed with the same animal can be seen**

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Agro-Met Advisory Services &Mechanism

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Dr. Satya Prakash[1]
[1]Assistant Professor, Department of Extension Education, DRPCAU, Pusa, Samastipur, Bihar.

By international agreement through the World Meteorological Organization, national weather, climate and water services are under governmental authority and responsibility. The governmental bodies responsible for such services are generally known as National Meteorological and Hydrological Services (NMHS), or National Meteorological Services (NMS). The Indian Meteorological Department (IMD) under the aegis of Ministry of Earth Sciences (MoES) is the NMHS in India. IMD is tasked with providing India's meteorological services and it does so through the Agro meteorological Advisory Services (AAS). Since its inception in 1845, IMD has been doing yeoman's job in providing meteorological services to farmers across the country. In 1945, it began providing weather information to farmers over the radio. For the sake of providing state level forecast-based advisories to farmers based on the short-range weather forecasts, Agro-meteorological advisories were first initiated in the year 1976.

In agricultural sector, site-specific weather predictions in the medium range which is provided 3-10 days ahead have a larger ability to safeguard farmers from potential losses due to weather aberrations. Keeping this in view, the Government of India in 1988 established the National Centre for Medium Range Weather Forecasting (NCMRWF). With the establishment of NCMRWF the mission was to develop Numerical Weather Prediction (NWP) model in order to forecast medium range weather. These forecasts are fine-tuned to discrete needs of farmers, especially in terms of advising activities and changes in specific agricultural practices, therefore assisting the farmers in making informed decisions.

With the intend to proclaim these forecasts and to fabricate forecast based agricultural advisories, the Agro-Meteorological Field Units (AMFUs) were created with infrastructural and technical support jointly from the Department of Science and Technology (DST), IMD, Indian Council of Agricultural Research (ICAR) and State Agricultural Universities (SAUs). These AMFUs were created across the country in 127 agro-climatic zones. Eighty-six fully functional AMFUs under SAUs were receiving medium range weather forecasts twice a week, which was valid for a 4–5-day period from NCMRWF. The weather forecasts are combined with the technical knowledge of the AMFU's advisory board, which consists of scientists representing a wide-ranging of agricultural disciplines including plant protection, soil science etc. The district-wide agro-advisories were prepared in both in English and local language. These advisories provided, contains location and crop-specific farm-level information, featuring details of current weather, soil and crop aspects, as well as recommendations for reducing losses and optimizing inputs viz. irrigation, fertilizer, and pesticides. An array of communication channels including radio, television, newspapers, websites, telephones etc. is used to circulate this advisory. The AAS was swiftly held up as an example of a successful multi-institutional and multi-disciplinary organization providing a significant service to India's farming community due to its vast nature of production and dissemination of information.

Generally, advisory disseminated by the AMFU covers regular climate information and weather events such as cyclones, floods, hailstorms etc. However, the lead-time of the communication is dependent upon the nature of the weather event. While a cyclone warning can be made four days in advance, location-specific warnings of heavy rainfall and hailstorms can only be given a few hours in advance.

The year 2007 witnessed integration of AAS with IMD under the Ministry of Earth Sciences. The month of June, 2008 marks the genesis of District-level Agro-meteorological Advisory Service (DAAS) with the objective to bring about district level agro-meteorological advisories based on weather forecasts. The ameliorated dissemination of advisories among the farmers will assist them in decision making regarding crop and livestock management. DAAS involves numerous stakeholders which entails ICAR, SAUs, Krishi Vigyan Kendras (KVKs), Department of Agriculture and Cooperation, State Departments of Agriculture/Horticulture/Animal Husbandry/Forestry, Non-Governmental Organizations and media agencies, thus making it a multi-institutional project.

The one hundred thirty agro-climatic zones in the country is represented by AMFUs, each covering about 4-6 districts. These AMFUs is bestowed with the responsibility of recording agro-meteorological observations through manual and automatic weather stations of the respective zones and to provide district wise agro-advisories with the assistance of advisory board consisting of scientist from various agricultural disciplines.

To augment the network of advisory services, IMD under Gramin Krishi Mausam Seva established District Agro-Meteorology Units (DAMU) in addition to already operating AFMUs. For this purpose, a Memorandum of Understanding has been signed between IMD and Indian Council of Agricultural Research. KVKs are currently being upgraded to serve as District Agro- Meteorology Units (DAMUs). DAMUs are entrusted with responsibility of preparing and circulating sub-district level/block level agro-met advisory bulletin. Each KVK is equipped with an Automatic Weather Station, and adding personnel with expertise in agro meteorology. IMD is responsible for funding the Automatic Weather Stations and the new personnel, as well as installing and training them.

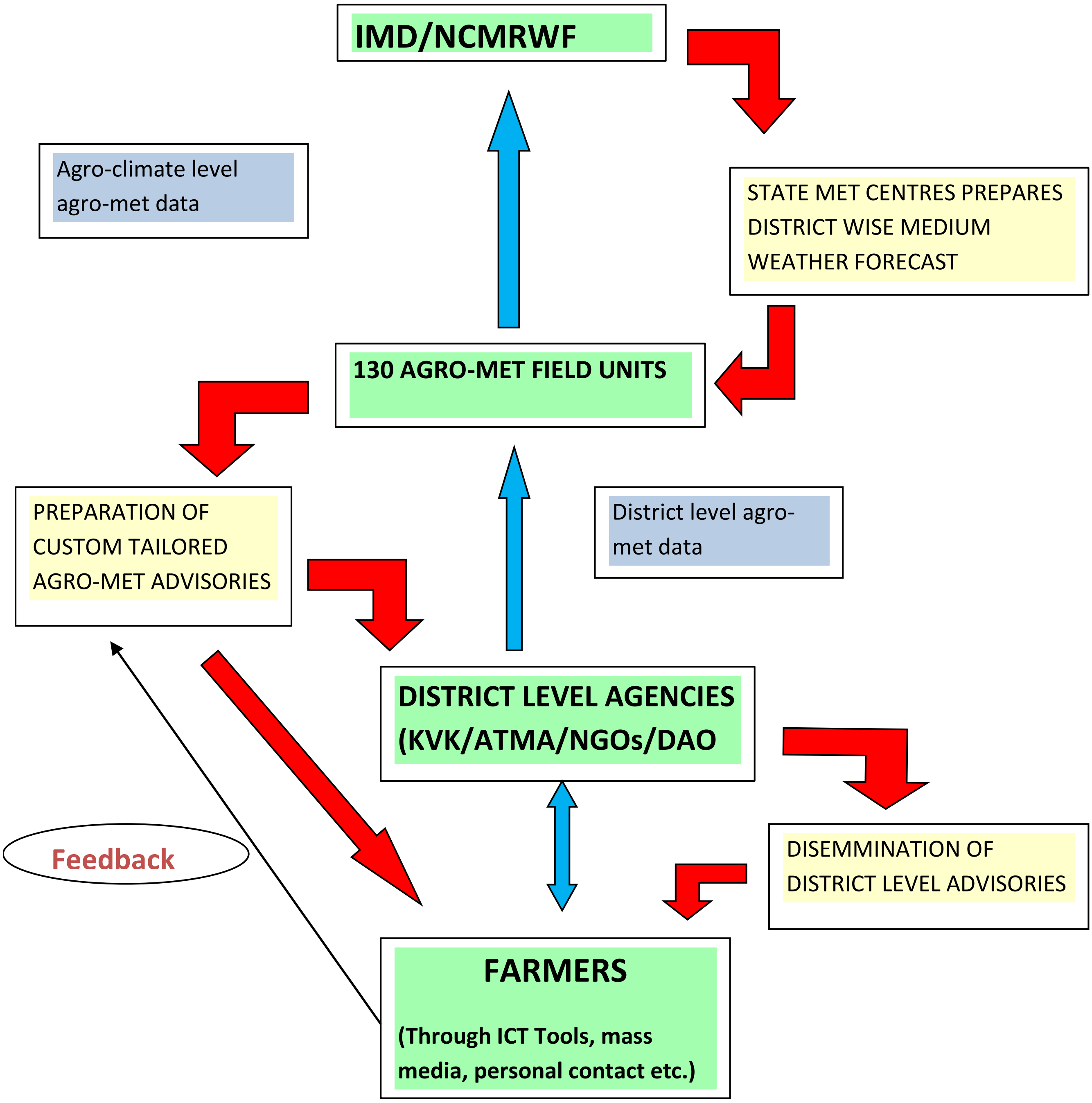

Figure 1: Mechanism of Agro-met advisory services dissemination (Source: IMD)

The Indian Council of Agricultural research (ICAR), along with the Central Research Institute for Dry land Agriculture (CRIDA) as the Nodal agency, has established 'All India Coordinated Research Project in Agro-Meteorology' (AICRPAM) in addition. Around 30 AICRPAM Centers have been established at various SAUs. These AICRPAM centers are also part of AMFUs and they rely on IMD's forecasts and the crop status provided by state agriculture departments. Agro-advisories based on weather are created and broadcasted all over by mass media communication, such as SMS, the Internet, and websites. Though agro-advisories have traditionally been the realm of government organizations, a few commercial companies have recently entered. Through a Memorandum of Understanding, IMD intends to include institutions (Indian Institute Technology, Indian Institute of Science, National Institute Technology, Universities, corporate organizations, and so on) in promoting integrated agro-advisory services across the nation.

Many private players like Skymet, Agrostar and NGOs like the Watershed Organization Trust (WTOR) is actively involved in providing Agro-met advisory services, but mostly are focused on agri-business sectors rather than farmers. There exist few private players has focus on innovating the process of linking local weather data with far level agricultural data and providing value added agro-advisories, targeted at farmers.

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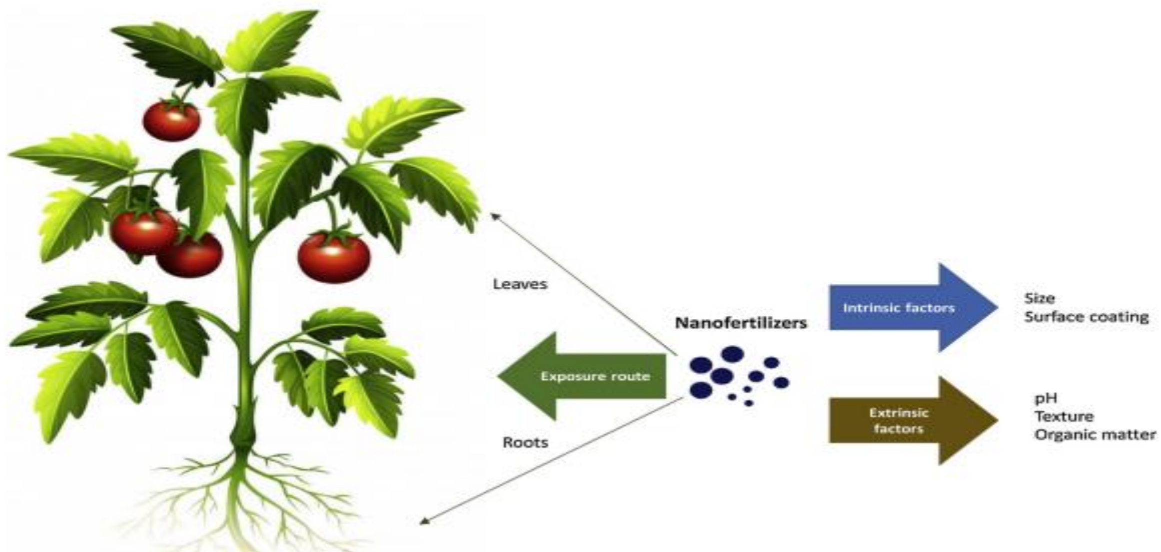
Nano-Fertilizers for Sustainable Crop Production: A Global Perspective

Article ID: 35082

Babu Lal Choudhary[1], Manish Yadav[2], Om Prakash Yadav[3], Suman Dhayal[4]
[1]PhD Research Scholar, Department of Soil Science, CCSHAU, Hisar, Haryana.
[2]PhD Research Scholar, Department of Soil Science, PAU, Ludhiana, Punjab.
[3]PhD Research Scholar, Department of Genetics & Plant Bredding, CCSHAU, Hisar, Haryana.
[4]Ph.DResearchScholar, Department of agronomy, Rajasthan College of agriculture, MPUAT, Udaipur.

Abstract
Nutrient fertilisation is essential for preserving soil fertility as well as increasing crop productivity and quality. Traditional fertilizers are not only expensive for the farmer, but they also have the potential to harm persons and the environment. As a result, ecologically friendly fertilizers, particularly those with high nutrient-use efficiency, are being sought, and nanotechnology is emerging as a possible alternative. Nanofertilizers can help with nutrition management because of their high potential for increasing nutrient utilisation efficiency. Nutrients are bound to nano-dimensional adsorbents, which release nutrients very slowly compared to conventional fertilizers, whether applied alone or in combination. This method not only improves fertilizer utilisation, but it also reduces nutrient loss into groundwater. Nanofertilizers can also be used to improve abiotic stress tolerance, and when combined with microorganisms (nano-biofertilizers), they provide even greater benefits.

Introduction
Fertilizers have been increasingly important in enhancing crop output and nutritional quality, especially since the introduction of fertilizer-responsive crop types. Nitrogen is the most important mineral nutrient for crop plants since it is a component of chlorophyll, as well as numerous proteins and enzymes, and thus plays an important role during crop vegetative growth. Loss of mineral nutrients through leaching and runoff to surface and ground water along with abundant volatilization constitute growing concerns owing to economic losses and environmental pollution. Nanotechnology is a promising topic of study that has the potential to provide long-term solutions to the pressing problems that modern intensive agriculture faces. Nanotechnology makes use of nanomaterials, which are typically 1–100 nm in size and offer unique properties and benefits due to their small size. In addition to a slew of other advantages, a large surface area allows nanoparticles to interact with target areas more effectively. Nanofertilizers have the potential to meet plant nutrition needs while also ensuring crop production systems' sustainability, all without affecting crop yield.



Strategic Potential of Nanotechnology in the Development of Fertilizers

Nanofertilizers have the potential to improve NUE by increasing nutrient uptake due to nanomaterials decreased surface area, which increases nutrient-surface contact. Along with boosting crops yield on sustainable basis, nanofertilizers hold potential to put a halt to environmental pollution caused by fertilizers. Slow-release fertilizers coated with nanoparticles dramatically reduced nitrate leaching and de-nitrification. Slow-release fertilizers are chemical compounds that have a poor solubility in water or other solvents and are broken down gradually and slowly by the soil microbial community. Furthermore, controlled-release fertilizers (which have a higher solubility than slow-release fertilizers but are coated with materials that reduce the active ingredient's exposure to the solvent, resulting in controlled liberation of nutrients through diffusion) coated with nanomaterials for reducing surface area may provide an excellent source of plant nutrients in the future.

Nanoscale Fertilizers and their Formulations

Different fertilizer inputs have been reported to be downsized into smaller portions using mechanical or chemical processes, which may boost nutrient uptake and reduce nutrient losses as well as toxicity. Urea, ammonia, peat, and other synthetic fertilizers, as well as plant wastes, have been used to make nanoparticles. Nano-sized N fertilizer was created via a formulation technique that involved urea deposition on calcium cyanamide. In another formulation, ground urea was combined with other biofertilizers to create an effective nanofertilizer that delivered nutrients over a longer length of time. In similar way, ammonium humate, peat and other synthetic materials were mixed to prepare nanosized fertilizers. To make such nanofertizers, a mechanical and biochemical approach is used, in which materials are mechanically ground into nanosized particles and then biochemical procedures are used to make efficient nanoscale formulations. In addition, nano-emulsions are made by combining emulsions with nanosized colloids.

In short, encapsulating fertilizers with nanoparticles opens up a lot of possibilities for generating plant nutrient sources that are more absorbent and efficient. The encapsulation of nutrients with nanomaterials can be performed in three distinct ways:

1. Plant nutrients can be encapsulated within the nanomaterials of varying nature and chemical composition.
2. Nutrient particles may be coated with a thin layer of nanomaterials such as polymer film.
3. Nutrients may also be delivered in the form of emulsions and particles having dimension in the range of nanoparticles.

Biological Mechanisms of Nanofertilizers

The use of root exudates and molecular transporters through ionic channels, as well as the development of new micro-pores, can boost nanofertilizer uptake. Nanopores and stomatal apertures in leaves have also been observed to facilitate the uptake of nanomaterials and their penetration deep within the leaves. Nanofertilizers have also been shown to have a greater NUE due to increased nutrient transport and delivery via plasmodesmata, which are nanosized (50–60 nm) channels for ion transfer between cells. Carbon nanotubes effectively served as molecular transporters, transporting fluorescent colours to tobacco cells through increased cell membrane penetration. The nanoparticles of silica were also instrumental in transporting and delivering different cargoes to target sites in different plants.

Nanofertilizers Advantages Over Conventional Mineral Fertilizers

Mineral nutrients if applied to crops in the form of nanofertilizers hold potential to offer numerous benefits for making the crop production more sustainable and eco-friendlier. Some of salient advantages are;

1. In contrast to chemical fertilizers, which release nutrients quickly and spontaneously, nanofertilizers nourish agricultural plants gradually and in a controlled manner.

2. Nanofertilizers are more effective in terms of nutrient absorption and utilisation since leaching and volatilization losses are much lower.

3. Nanoparticles have a substantially higher intake rate due to free passage through nanoscale pores, molecular transporters, and root exudates; nanoparticles also use a variety of ion channels, resulting in increased nutrient uptake by agricultural plants.

4. Nanofertilizers offer the biggest benefit in terms of small losses which lead to lower risk of environmental pollution.

5. Smart nanofertilizers such as polymer coated fertilizers avoid premature contact with soil and water owing to thin coating encapsulation of nanoparticles such as leading to negligible loss of nutrients. On the other hand, these become available as soon as plants are in position to internalize the released nutrients.

Conclusions

Nanofertilizers applied alone and in conjunction with organic materials have the potential to reduce environmental pollution owing to significant less losses and higher absorption rate. Nanomaterials were also found to boost germination rate, plant height, root development and number of roots, as well as leaf chlorophyll and antioxidant content. Furthermore, regulated and slow-release fertilizers with nanoparticle coatings improve nutrient use efficiency and absorption of photosynthetically active radiation while reducing nutrient waste. The future of nanofertilizers for sustainable crop production, as well as the time required for their widespread adoption as a source of plant nutrients, is dependent on a number of factors, including effective legislation, the development of novel nanofertilizer products to meet demand, and risk management.

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Temporal Variation of Water Use Efficiency in Canal Command

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Jitendra Rajput[1], Mahesh Kothari[2], Dimple[2], Ashish Rai[3], Nand Lal Kushwaha[1], Pradosh Kumar Paramguru[4]

[1]Scientist, Division of Agricultural Engineering, ICAR-IARI, New Delhi-110012, India.
[2]Ph.D Scholar, Department of Soil and Water Engineering, MPUAT, Udaipur-313001, Rajasthan.
[3]SMS, Krishi Vigyan Kendra, Parsauni, RPCAU, Pusa, Bihar-848125, India.
[4]Scientist, ICAR-IINRG Campus, Ranchi, Jharkhand, 834010, India.

Introduction

Improvement of canal irrigation system performance is essential to enhance crop water use efficiency under current trend of elevating water scarcity, demographic explosion, urban area expansion and unreliability of rain distribution pattern. Initially, agricultural physiologists described water use efficiency as the quantity of carbon assimilated and crop production per unit of transpiration (Viets, 1962), and subsequently as the quantity of biomass or sellable yield per unit of evapotranspiration. De Wit (1958) was among the first to do this and he expressed the water use efficiency in kilogram of crop production per cubic-meter of water transpired.

Irrigation engineers and scientists have been using the word water (irrigation) efficiency to explain how efficaciously water is delivered to plants and also to imply the quantity of water lost at the plot, farm, command, or system level.

However, this definition of water use efficiency offers only an incomplete view since it does not explicitly state the overall advantages generated, nor does it clarify that water lost by irrigation is frequently repurposed by other users (Seckler et al., 2003). Quantitative assessment of water use efficiency is a function of crop production and the volume of water utilized during the growing period. Present article describes the temporal variability of water use efficiencies of *Rabi* crops in Bhimsagar irrigation command area.

Water use Efficiency of *Rabi* Crops

Crop water use efficiency (CWUE) and field water use efficiency (FWUE) for period 2009-10 to 2013-14 were calculated for major principal crops in Bhimsagar canal command area, Jhalawar, Rajasthan, India. The crop yield data were recorded for five years and crop water requirement was estimated employing CROPWAT 8.0 software.

Gross Irrigation Requirement (GIR) was estimated considering field application efficiency value as 70 %. Crop and field water use efficiency measure's ability of crops that, how efficiently water has been utilized in crop production. Wheat is one of the major crops grown in Bhimsagar canal command area and has highest coverage amongst *Rabi* season crops.

Maximum value of CWUE for wheat crop was calculated as 159.49 kg/ha-cm in 2013-14 while Minimum was obtained in 2010-11 with value 113.74 kg/ha-cm. The crop water use efficiency for mustard was estimated in 2013-2014 with value as 62.35 kg/ha-cm while minimum value found in 2009-10 with value as 37.05 kg/ha-cm.

The crop water use efficiency for coriander was maximum in year 2012-13 with its value 47.90 kg/ha-cm due on account of sufficient water for irrigation. The minimum CWUE was observed in 2009-10 with value 43.84 kg/ha-cm.

Results showed that water use efficiency of garlic was maximum in 2013-14 with value 147.86 kg/ha-cm and minimum in year 2009-10 with value of 116.49 kg/ha-cm. Temporal variability of crop water use efficiency for wheat, garlic, coriander, and mustard crops during period 2009-10 to 2013-14 has displayed in figure 1.

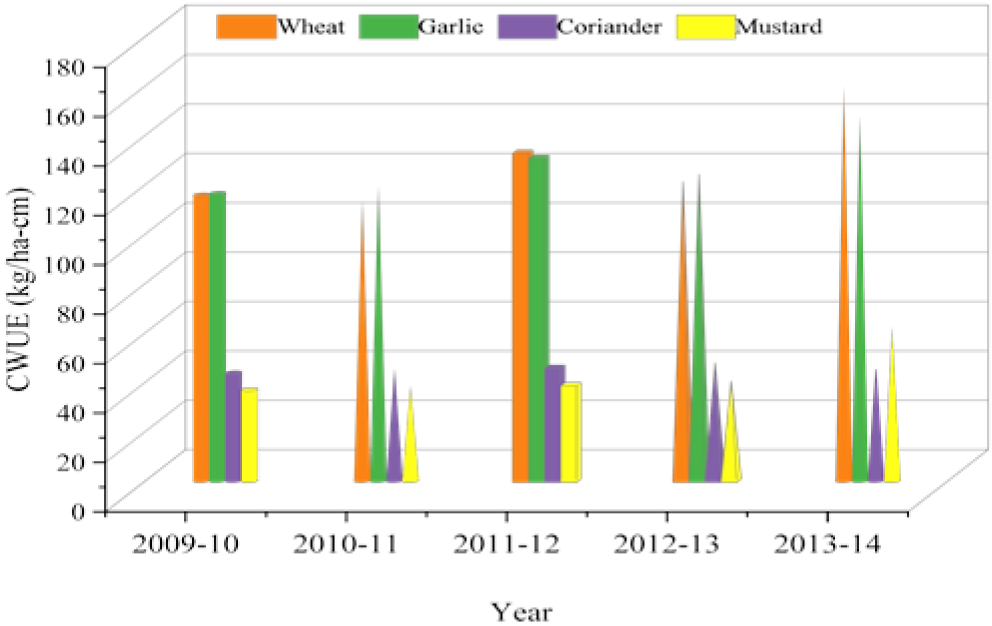

Figure 1. Crop water use efficiency (CWUE) during 2009-10 to 2013-14

Field water use efficiency (FWUE) was calculated for *Rabi* crops during 2009-10 to 2013-14. In year 2009-10, garlic attained highest FWUE with value of 81.53 kg/ha-cm followed by wheat (81.11 kg/ha-cm), coriander (30.69 kg/ha-cm) and mustard (25.93 kg/ha-cm). Garlic has given maximum value of FWUE (87.13 kg/ha-cm) of all crops in year 2010-11. In the year 2011-12, Garlic had utilized water effectively and gave highest FWUE whereas Mustard attained minimum water consumption ability. Garlic had attained highest FWUE of 84.18 (kg/ha-cm) whereas mustard had attained lowest FWUE of 28.34 (kg/ha-cm) in year 2012-13. Garlic and wheat have observed improvement in water utilization efficiency by attaining higher values of FWUE whereas coriander had failed to use water effectively. Temporal variation of field water use efficiency for *Rabi* season crops during period 2009-10 to 2013-14 has shown in figure 2.

Figure 2. Field water use efficiency of *Rabi* Crops during 2009-10 to 2013-14

Conclusions

Crop water use efficiency of wheat, garlic and mustard attained maximum values of 159.49 kg/ha-cm,147.86 kg/ha-cm and 62.35 kg/ha-cm respectively in year 2013-14 while coriander attained maximum value of 47.90 kg/ha-cm in 2012-13. Wheat performed consistently well from 2009-10 to 2013-14 and attained highest value of field water use efficiency (FWUE) of 111.64 kg/ha-cm in year 2013-14. Garlic obtained highest FWUE in 2013-14 with value of 103.55 kg/ha-cm. Coriander attained lower value of FWUE in year 2009-10 (30.69 kg/ha-cm) whereas Mustard obtained highest value in year 2013-14 having FWUE of 43.64 kg/ha-cm. Crop water use efficiency is helpful in selection of proper cropping pattern with objectives of net benefit maximization under the water scarcity scenarios. Water use efficiency can be enhanced by employing precision irrigation techniques like drip irrigation, sprinkler, mulching and best management agronomical practices to improve crop yield including optimum fertilizers doses, weeding operations and other agronomical aspects.

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Breeding Approaches for Drought Resistance

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Anju Nehra[1]
[1]Department of Plant Breeding and Genetics, S.K.N. Agriculture University Jobner, Jaipur 303328 (Rajasthan).

Introduction

The inadequacy of water availability, including precipitation and soil moisture storage capacity, in quantity and distribution during the life cycle of a crop to restrict the expression of its full genetic yield potential.

Drought accounts for 26% of the arable land among abiotic factors, 85% of the cropped area of the world is under rainfed and 82% of the potentially arable land is already under cultivation, prospects of increasing irrigation are troubling due to related costs.

Effects of Drought on Plant Growth and Development

1. Low Level of Stress: Stomatal resistance, Decrease in turgor pressure, Reduction in cell enlargement, Photosynthate partitioning, Osmotic adjustment, Root growth.
2. Moderate Level of Stress: Rate of photosynthesis affected; Senescence of older leaves occurs.
3. High Level of Stress: Stomata close fully, Turgor is lost, rolling up of leaves, Gas exchange drops to zero, Carbon is lost by respiration, Canopy temperature increases, Photosynthetic translocation affected.

Types of Drought Environment

1. Stored moisture environment.
2. Variable moisture environment.
3. Optimal moisture environment.

Drought Resistance

The mechanism causing minimum loss of yield in a drought environment relative to the maximum yield in a constraint-free (optimal) environment for the crop.

Mechanisms of Drought Resistance

Drought escape, Dehydration avoidance, Dehydration tolerance.

Drought Escape

The situation where an otherwise drought susceptible variety performs well in a drought environment just by avoiding the period of drought and early maturity is an important trait of drought escape.

Drought Avoidance

The ability of a plant to retain a relatively higher level of hydration under conditions of soil or atmospheric water stress and it is measured by the tissue water status expressed by water potential.

Two Plant Types Come Under this Category

1. Water savers.
2. Water spenders.

Selection Criteria

Yield potentials of genotypes under favourable and stress environment, Leaf wilting, leaf firing and leaf rolling, Seed germination, seedling emergence, survival, vigour and recovery, Screening based on root studies, Canopy temperature measurements, Photosynthesis and other metabolic approaches.

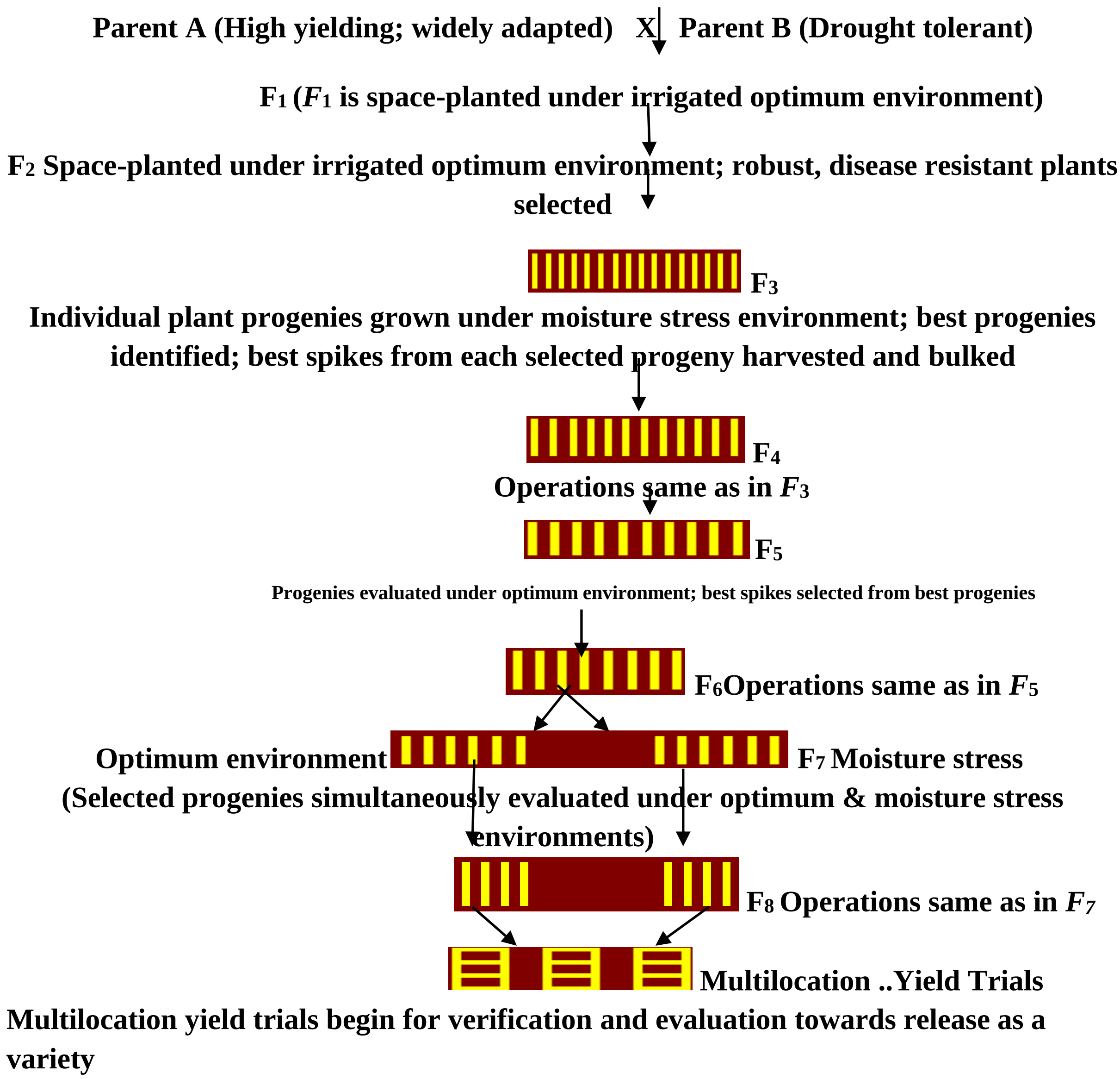
Evaluation based on water retention capacity and water potential of leaves, Membrane stability, Evaluation based on plant phenology, Remobilization of stored photosynthates, Evaluation based on biochemical and molecular markers, Pollen based selection criteria, Evaluation based on multi-environment test.

Breeding Approaches for Drought Resistance

Conventional Breeding: To breed for high yield under optimum (water-stress-free) condition, to breed under actual drought condition and simultaneous selection in non-stress environment for yield and in drought condition for stability.

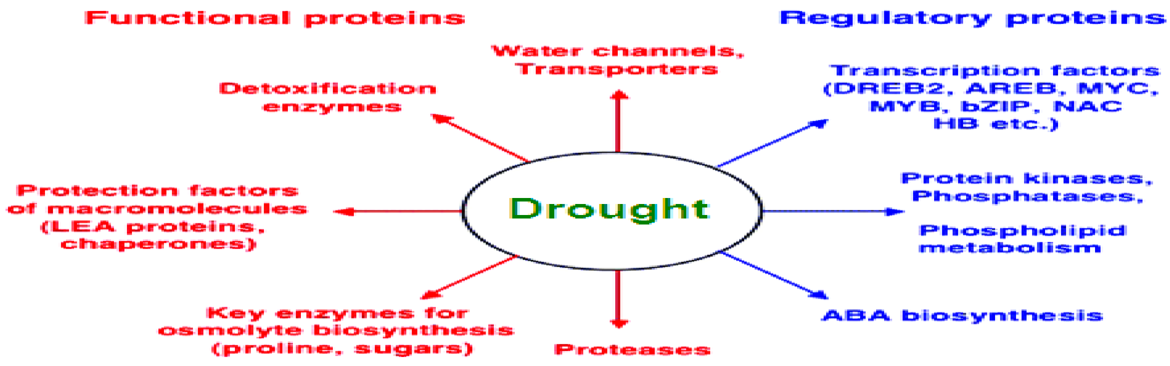
Breeding Methodology: In general, pedigree and bulk method could be used for self-pollinated crops and recurrent selection for cross-pollinated crops, if transfer of few traits relating to drought resistance to a high-yielding genotype is the aim, then back cross is the appropriate methodology and biparental mating (half sib and full sib) maintains the broad genetic base.

Shuttle Breeding Approach



Transgenic Breeding

1. Genes encoding functional proteins.
2. Genes encoding regulatory proteins.



Transgenic Approaches for Developing Drought Resistant Plants:

a. Direct/Targeted approach: Metabolic pathways involving the synthesis of different metabolites such as polyamine, carbohydrate, proline, glycine betaine and trehalose have been shown to be associated with drought resistance. This approach relies on the availability of relevant information on biochemical reaction for synthesis of these metabolites and utilizes the related genes to transfer them from different sources to crop plant. This approach is more precise and methodical, having a higher probability of success in comparison to the shotgun approach. In recent years, introduction of drought-induced genes involved in different biochemical pathways from different sources to sensitive plants has evolved as one of the promising methods. Gene, P5CS, encodes for pyrroline-5-carboxylate synthetase which is involved in proline synthesis, and the over-production of proline confers drought resistance. Transgenic tobacco over expressing P5CS gene transferred from moth bean exhibited a high level of enzyme and produced 10–18-fold more proline than control plant. The over-production of proline enhanced root biomass and flower development under drought condition. SOD (superoxide dismutase) gene from pea has been transferred to tobacco and transgenics were found to be drought resistant.

b. Indirect/Shotgun approach: Genes, which are expressed under drought and for which no specific role has yet been proven, are identified. Though the approach is less precise with low probability of success, the strategy can work even as there is no prior information about the gene or gene product. Thus, the shotgun approach appears to be better choice due to dearth of sufficient information on biochemical changes in the cell for drought resistance. Transgenic rice carrying barley hva1 gene produced through this approach has shown drought resistance hva1 encodes for a group of three LEA (late embryogenesis abundant) proteins which gets accumulated in vegetative organs during drought condition.

Molecular Breeding: Molecular markers such as restriction fragment length polymorphism (RFLP), random amplified polymorphic DNA (RAPD) and isozyme will facilitate development of drought-resistant genotypes more effectively as their expressions are independent of environmental effects. After identification of the molecular markers associated with yield or other morphological traits related to drought resistance, those markers could be used as a selection criterion for drought resistance. The application of marker-assisted selection in evolving drought resistant genotypes is in an experimental stage; more specifically just identification of RFLP markers associated with osmotic adjustment, stay green, root traits has been achieved.

Constraints in Breeding for Drought Resistance

1. Lack of efforts through multidisciplinary approach to understand the integrated plant responses to drought and complex genetic control of different mechanisms of drought resistance.
2. Lack of repeatable and precise screening techniques.
3. Knowledge is incomplete about reliable attributes as indices of drought resistance, selection criteria and influence of environment on drought-related traits.
4. Several adaptations reducing water loss under drought seem to have a negative effect on crop productivity. For instance, both leaf rolling and stomatal closure conserve water in plant, but reduce light

interception and entry of carbon dioxide into leaf and in turn, reduce the yield. These traits are not useful in breeding drought resistance.

5. Drought reduces nutrient uptake and is associated with temperature stress and at higher elevation with cold. This association makes the breeding programme more complicated.

6. Despite the realization about the importance of water- use efficiency and the availability of its genetic variability, selection for high water-use efficiency often results in decrease in crop growth rate. Most often plants evolve to maximize water-use efficiency through reduction in transpiration. Since dry matter production is strongly associated with total transpiration, any reduction in transpiration results in reduced crop growth rate.

7. Limitation in application of genetic engineering on this aspect is owing to the lack of information on availability of the most appropriate gene.

Future Strategies

1. There is an urgent need for exploration of the plant genetic resources with attributes related to drought resistance in different crop plants and their characterization to facilitate transfer of desired traits through conventional plant breeding or biotechnological method.

2. A single trait cannot confer drought resistance satisfactorily. Therefore, breeding programme for drought resistance should aim at pyramiding a number of relevant traits in a crop.

3. Plant genetic engineering also generated transgenic plants with only one transgene in all cases. Many different genes responsible for biosynthesis of different solutes and osmolytes conferring drought resistance should be considered for transfer in a crop plant at a time.

4. Attention should be concentrated on better understanding of genetic basis of drought resistance observing the effect of expression level of different enzymes/ proteins in different biochemical pathways on drought resistance.

5. Several stress proteins (such as LEA, dehydrin, etc.) are synthesized and accumulated in plant tissues under drought condition. A comparative assessment of various polypeptides produced in response to drought, between sensitive and tolerant genotypes may be used in identification of protein marker, which could help in producing transgenic drought resistant plants.

6. A multidisciplinary approach involving genetics, biochemistry, biotechnology, physiology, plant breeding and crop science will be appropriate to assess the complicated and integrated response of plants to drought and to evolve superior drought resistant genotypes.

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Food Rheology

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Nisha R[1], Nickhil. C[2], Ashitha G. N[3], Amirtham. D[4]
[1]University of Agricultural Sciences, Chamarajanagara, Karnataka.
[2]ICAR -Central Institute of Agricultural Engineering Bhopal, Madhya Pradesh.
[3]Kelappaji College of Agricultural Engineering and Technology, Tavanur, Kerala.
[4]ICAR - Indian Agricultural Research Institute, New Delhi.

Introduction

Foods are made up of a wide range of biological ingredients with different rheological characteristics. Understanding food behavior is a crucial part of the food industry because it helps answer important questions like whether a certain food product would easily deform, flow through a pipe, or work well as a topping. Food rheological characterization is crucial for food development, optimization, and processing once again.

The rheology of food also influences its texture. Rheological flow properties control how we perceive food when we touch it or put it in our mouth. Fluid mechanics is the most basic understanding of food rheology. The association between stress and strain, according to the researchers, might be utilized to analyses the rheological features of food systems in various models.

Rheological Behavior of Food

Food is a complex-structured material which are made up of proteins, carbohydrates, lipids, fibers, and water. These components of the food determine the flow and structural behavior, and the stability of structured fluids. The flow property of a food material is affected by the viscosity of the liquid phase in dispersions, for example: A food product's dispersion properties, such as emulsions or suspensions, can be used to predict its behavior. Food dispersion is crucial in a variety of everyday meals, such as mayonnaise, tomato paste, sauces, and infant food.

Particle size distribution, particle concentration, and inter-particle interactions all influence the rheological behavior of dispersions. According to academics, suspensions are made up of solid particles suspended in a fluid medium. Emulsions, on the other hand, are made up of a suspension of liquid droplets in a liquid medium (deformable particles). The temperature and measurement duration have a significant influence on the rheological properties of food.

Importance of Rheology

Food rheology describes the behaviour of liquid foods. The microstructure of liquid food has a big impact on the product's quantitative and qualitative qualities. Numerous physicochemical interactions and inter/intramolecular linkages determine the microstructure of complex food components. In most circumstances, microstructure has an impact on the material's flow characteristics. The heat and mass transfer associated with heating, pumping, and combining ingredients, for example, are aided by viscosity and elasticity, which are equivalent to the liquid-like and solid-like components of the food. This ensures that the meal ingredients' liquid content is sufficient.

Rheological qualities are significant in mass transfer because they determine important actions including drying, fermentation, and separation. Viscometers and rheometers can be used to measure these two rheological characteristics. The texture of the food substance is another significant aspect of microstructure. The texture of food influences how it is perceived in the mouth. Over- or under-processing, such as the use of excessive or insufficient shear or heat while processing the product, can have a negative impact on the texture. The finished food product's quality is ensured by measuring the rheological parameters. According to some researches, the behaviour of liquid food is influenced by the amount of stress applied to it. Fat-based spreads, molten chocolate, mashed potatoes, and certain salad dressings, for example, behave like liquids under high stress and solids under low stress. Textural flaws in processed foods are reduced through a thorough grasp of food rheology and microstructure, which increases consumer pleasure. Food rheology is defined by some scientists as the study of the deformation and flow of food material under well-defined conditions. They went on to say that this research is critical in many aspects of the food sector.

Measurement of the Rheological Property in Foods

For the measurements of any food material basic tests carried out are:
1. Rotational test and viscosity.
2. Oscillation test and viscoelasticity.

Rotational Test and Viscosity

Rotational testing with a rheometer can be performed in one of two modes, each with its own set of parameters. The first method is to display velocity as rotating speed or shear rate (controlled shear rate, CSR or CR). This replicates operations that rely on flow velocity or volume flow rate, such as brushing on coatings, spraying on paints, or flowing through a tube (Figure 1). The second method is to use torque or shear stress to set the driving force (controlled shear stress, CSS or CS).

These tests imitate force-dependent applications, such as the force needed to start pumping a substance from a standstill, push sealing ingredients out of a cartridge, or squeeze paste out of a tube. Conversion factors can be used to convert torque into shear stress and rotational speed into shear rate, and vice versa.

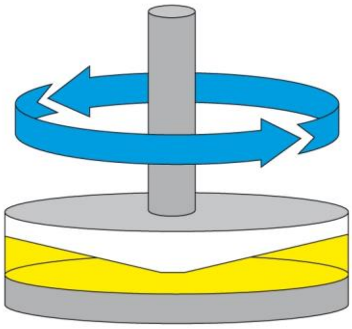

Fig 1: Rotational shear test on a sample; the cone rotates while the lower plate is stationary.

Oscillation Test and Viscoelasticity

The oscillatory testing can also be explained using the two-plates concept (Figure 2). While sandwiched between two plates, a sample is sheared, with the upper plate moving and the lower plate remaining stationary. As long as the wheel is moving, a push rod attached to the driving wheel pulls the upper plate back and forth parallel to the lower plate. The model functions at a constant oscillation frequency while the rotational speed is constant. The upper, moveable plate's deflection path is measured and rheologically assessed as strain or deformation. When the driving wheel rotates, the strain versus time produces a sine curve with the strain amplitude A. In most cases, the parameters for oscillatory tests are set in the form of a sine curve. The test is a controlled sinusoidal strain test for the two-plates model, as explained above. The amplitude (maximum deflection) and oscillation period of a sine curve are determined. The reciprocal of the oscillation time is the oscillation frequency.

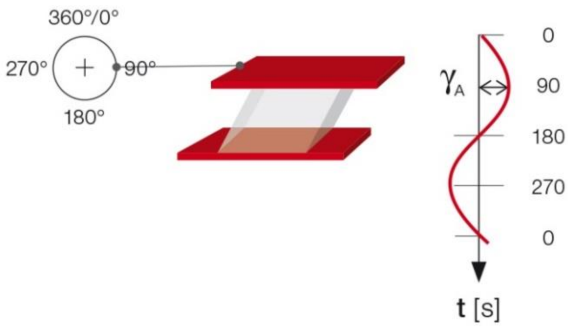

Fig 2: Oscillatory test illustrated by the use of the two-plates model with driving wheel and push rod for shear tests.

The following are some of the most important applications:

1. Assists in the development of a new product.
2. Assists in determining the physical properties of liquid and semi-solid meals.
3. Determining the quality of raw materials to be utilised in the production of a certain product, as well as evaluating the quality of the food product at various stages of its development.
4. Trying to figure out how long food products will last.
5. Assessing the sensory characteristics of food.
6. Assisting in the understanding of food microstructure (indirect study).
7. Rheological data aids in the development of industrial plant designs, which include pump and pipe selection. It provides computations for extruders, mixers, coaters, and homogenizers in process engineering.

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Role of Biopesticides in Sustainable Agriculture

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Srishti Choudhury[1], Abhibandana Das[2], S. K. Sahoo[3]
[1]M.Sc. Student, [2]M.Sc. Student, [3]Associate Professor,
Department of Entomology, Post Graduate College of Agriculture, Dr. Rajendra Prasad Central Agriculture University, Pusa (Bihar) 848125.

Introduction

In the past few decades production of food grains have increased through the use of chemical fertilizers, plant protection chemicals etc. But modern agricultural practices are exhaustive in nature. Repeated use of agrochemicals has degraded soil health and reduced fertility, making the land unsuitable for farming. They have also become environmental pollutants. Keeping these demerits in mind, the focus has now shifted to judicious use of agricultural inputs while keeping the food production intact and the environment safe. Therefore, emphasis is now being paid to adopt sustainable agriculture. Agricultural systems which provide safe and nutritious food, are economically viable and at the same time maintain natural resources for present and future generations are known as sustainable agricultural systems. In this scenario, biopesticides play a major role. A number of tools are available which can help us in achieving sustainable agricultural production and biopesticides seem to be a viable option.

What is Biopesticide?

Biopesticides or biological pesticides are pesticides which are derived from naturally occurring substances such as plants, insects, nematodes and microorganisms. The US EPA states that biopesticides include "naturally occurring substances that control pests (biochemical pesticides), microorganisms that control pests (microbial pesticides), and pesticidal substances produced by plants containing added genetic material (plant-incorporated protectants) or PIPs". As of April 2016, there are 299 registered biopesticide active ingredients and 1401 active biopesticide product registrations. (www.epa.gov).

Classes of Biopesticides

According to **US EPA** (Environmental Protection Agency), they mainly fall into 3 categories:

1. Biochemical pesticides- These are naturally occurring substances that control pests by non-toxic mechanisms.

2. Microbial pesticides - It consists of a microorganism (e.g., a bacterium, fungus, virus or protozoan) as the active ingredient. Each separate active ingredient is relatively specific for its target pest.

3. Plant Incorporated Protectants (PIPs) - Pesticidal substances that plants produce from genetic material that has been added to the plant. They have genetic material from other species incorporated into their genetic material (i.e., GM crops).

In the management of insect pests, natural enemies such as predators and parasitoids are also used as biopesticides. In crops like cotton, parasitoids, beetles, wasps, lady birds and lace wings are used to control destructive pests such as boll worms (*Helicoverpa armigera*).

Why Sustainable Agriculture?

Many harmful effects are associated with the use of pesticides. Synthetic pesticides are non-biodegradable in nature and cause environmental pollution. As the constituents of these chemical pesticides are retained in the soil, it makes them unsuitable for crop production. Continuous and non-judicious use of synthetic pesticides leads to resistance build up in insects, pest resurgence as well as secondary pest outbreaks. While managing target pests, they also kill non-target beneficial insects, thus disrupting biodiversity. Human toxicity and health effects are some other major problems linked with pesticide usage.

Sustainable agriculture minimises the use of chemicals and prevent their harmful effects on environment. It maintains balance in the natural ecosystem. Sustainable crop production lays emphasis on managing nutritional and biological stresses through organic, cultural and biological means, hereby bringing biofertilizers and biopesticides to play a significant role.

Role of Biopesticides in Sustainable Agriculture

In conventional agricultural practices farmers use chemical pesticides injudiciously and indiscriminately. The excessive use of these chemicals has stretched out several of their negative effects, mostly environmental pollution, climate change and harm to humans and non-target insects. The main aim of sustainable agriculture is to save and conserve the natural resources so that they are available for use for the future generation. Biopesticides play a crucial role in sustainable agriculture because it is an effective alternative which successfully manages crop pest without degrading the natural resources involved in agricultural systems. This means that the use of biopesticides allow us to conserve the natural resources without compromising in crop production. Biopesticides are selective in nature, meaning they do no harm to the natural predators and other beneficial organisms. Thus, maintaining the natural ecosystem and biodiversity of an area. Following are some pros of biopesticides which help us understand why it plays an important role in sustainable agriculture.

1. Since biopesticides are derived from natural or biological origin it is safe to use them as potential source of pest control in sustainable agriculture.

2. Biopesticides are eco-friendly. They are low volatile compounds and so have low environmental risks. They are easily biodegradable and non-persistent. As they produce very minimum number of residues, their presence is almost negligible in the water, air and terrestrial ecosystems.

3. Because biopesticides produce minimal residues they can be applied on the field towards later part of crop growth period. Hence, insects attacking at late stage can be controlled safely.

4. They have a short waiting period or no pre-harvest interval. They allow growers and farm workers to enter fields immediately after usage, saving time, crops and money. Farmers can harvest their produce after a few days of biopesticide application.

5. Due to their low persistence, pre-harvest interval is not needed and hence it becomes a major factor in export of crops.

6. They are safe to use on fresh vegetables and fruits as they do not pose any residue issues.

7. Their short re-entry interval ensures applicant’s safety.

8. Biopesticides are selective and species specific in nature. They do not attack non-target species and so the proliferation of beneficial organisms like parasitoids, predators and pollinators is encouraged.

9. Many experiments have proved that biopesticides and conventional synthetic pesticides approximately have similar potency, i.e, their effectivity is similar.

10. Because of their multiple and non-specific mode of action, resistance or cross-resistance to biopesticides is seldom developed by the pests. Biopesticides do not cause development of resistance or resurgence in pest. They are also found to be effective to insect pests that developed pesticide resistance.

11. They also do not lead to secondary pest outbreak.

12. They are inexpensive as their source materials are easily available within the natural environment.

13. To control insect pest in agriculture dependent rural areas, crudely extracted plant insecticides are more economical in comparison to conventional insecticides.

14. Biopesticides have a non-toxic nature. Hence, safe for both the applicants and the consumer.

15. The negative impact of bioaccumulation of toxic compounds in the food chain can be greatly reduced by the use of biopesticides.

16. The introduction of important microbial species in the form of biopesticides helps to decontaminate agricultural soils.

17. They are compatible with chemical insecticides and microbial agents and can therefore be easily incorporated in Integrated Pest Management.

18. Biointensive pest management (BIPM) is a strategy where microbial biopesticides are incorporated into IPM to increase the effect of augmented natural enemies. BIPM emphasize on proactive measures to redesign the agricultural ecosystem to the disadvantage of insect based and to the advantage of its parasite and predator complex.

19. Bio pesticides are effective in small quantities and require reduced number of applications.

20. Use of biopesticides defines wholesome organic farming where in true sense toxin-free food and crops are produced.

Limitations in the Use of Biopesticides

There are plentiful advantages of using biopesticides, but certain factors exist that put a limit in their full adoption as an effective measure in pest management. Biopesticide efficacy in field conditions requires high doses of constituent compounds. But while making the formulation, it is sometimes difficult to get the active ingredients in required right proportions. Due to the non-availability of guidelines and standard preparation techniques for efficacy testing, some inconsistencies are seen at field level. Poor quality of source materials and low shelf life also lead to such inconsistencies. Factors like temperature and moisture which affect the shelf life of natural extracts in biopesticides are sometimes difficult to control. Data on toxicity, chemistry, packaging and formulation required for registration of the biopesticides are not always readily available. Illiteracy and lack of awareness regarding biopesticides, especially among the marginal and small-scale farmers makes their adoption process difficult. It is difficult to invest in biopesticides due to lack of easily available markets. The expense of developing a new pesticide product is often high and there are several resource constraints as well. Particularly in under developed nations, biopesticide manufacturing is hampered by lack of resources and capital. Synthetic pesticides compete fiercely with biopesticides in the current scenario and if the later were created for a modest agricultural activity, it will most likely be expensive and hence not feasible.

Conclusion and Future Prospects

Synthetic pesticide usage leads to many problems due to their negative effect on environment, human toxicity and health effects. Biopesticides offer a better alternative to synthetic pesticides as they are inherently less toxic, decompose quickly resulting in lower exposure, effective in small quantities and have low persistence in the environment. These properties also make it a suitable part of IPM. As a component of sustainable agriculture, biopesticides can lower the use of conventional pesticides while producing desirable yields. However, for the safe and effective use of biopesticides, users must be well versed in pest management and strictly adhere to all label instructions. To meet the need of the hour, researchers should collaborate with the government, industry engineers and farmers to develop durable and stable biopesticides formulations.

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https://www.epa.gov/ingredients-used-pesticide-products/what-are-biopesticides.

Equipment for Plant Protection

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Priya Singh[1], Inkresh Kumar Verma[1]

[1]Department of Plant Pathology and Nematology, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar.

Agrochemicals are widely used in agriculture for application of insecticides, fungicides and weedicides. They can save our crops from insects, diseases and weeds when applied at proper time and at proper dose. They are applied either to soil or plants in form of dust, spray and mist. These chemicals are very expensive so they must be advocated wisely and uniformly to the crop canopy. The plant protection equipment does this job quite well by uniform and effective application of chemicals. The selection of these equipment should be in accordance with the condition of crop damage, method of application, dose and time of application. Sprayers and duster are commonly used for agrochemicals application. Dusting is the simplest method of chemical application but it is less efficient than spraying.

Dusters

Duster consists of a hopper which usually consists of an agitator, fan/blower, an adjustable orifice and delivery tubes. The dust particles are kept agitated by in the hopper and thereafter fed to the air current to discharge the particles into fine dust. The dust particles are discharged both horizontally and vertically in form of clouds.

Types of Dusters

1. Hand operated dusters/Manually operated dusters.
2. Power operated dusters.

Hand Operated Dusters

1. Plunger (Piston) Duster/Hand Pumps – It is simple in construction consisting of dust chamber, a cylinder with piston or plunger, a rod and a handle. It is small, cheap and easy to operate.

Uses – Kitchen gardens and household in fumigating rodents' burrows with calcium or sodium cyanide

2. Bellows duster – It has a pair of bellows made of leather, plastic or rubber. The dust is placed either in bellows or in separate container made up of wood, plastic or metal. Dust is discharged by air current created by movement of bellows.

Uses – Kitchen Garden and domestic pest control.

3. Hand Rotary (Crank) duster/Fan type duster: They may be shoulder mounted, belly or back mounted. It consists basically a blower complete with gear box and hopper (4-5 kg capacity). The duster is operated by rotating crank and then motion is transmitted through gear to blower. The air current produced by blower draws dust from the hopper and discharge out through the delivery tubes consisting of one or two nozzles.

Uses – Field crops, vegetables, small trees and bushes in orchards.

Power Operated Dusters

In this power operated motors (engine/PTO shaft of tractor/flywheel of power tiller) are used to run the agitator inside hopper and blower. They resemble the rotary duster in construction, except that the power to run the blower is trapped from an external source.

Sprayers – These are most commonly used equipment in application of pesticides.

Requirements of a Good Sprayer

1. Uniform distribution of chemicals on plant surface.
2. Provision to increase or decrease the quantity of pesticide application.

3. Break the liquids into fine droplets.
4. Provision to regulate the size of droplets.

Parts of Sprayer

1. Tank: Metal or fibre glass tank of varying capacity from 400 to 1500 litres are used in conjugation with suction pipe and drain plug.
2. Pump: Pneumatic type or Plunger type or Rotary type or Centrifugal type or Diaphragm type.
3. Agitator: Mechanical or hydraulic agitators to mix chemicals before and during spaying operation.
4. Air chamber: Provided with plunger to create working pressure.
5. Pressure regulator: To regulate working pressure.
6. Pressure gauze: To measure working pressure.
7. Nozzles and pipes: Gaseous energy nozzle or centrifugal energy nozzle or Kinetic energy nozzle or thermal energy nozzle or hydraulic nozzle or cone nozzles may be used with metallic or rubber pipes.

Types of Sprayers

On basis of energy employed to atomise and eject spray fluid (suspension, emulsion or solution) the sprayers are classified into following types:
1. Hydraulic energy sprayers - The spray liquid is directly pressed through a plunger or piston to discharge the liquid.
2. Gaseous energy sprayers/compression sprayers/Air sprayers/Pneumatic sprayers: To discharge the spray liquid, a stream of air is compressed through piston which in turn presses the spray fluid.
3. Centrifugal energy sprayers/Mist blowers/Mist sprayers: The spray liquid under low pressure is fed to the center of high-speed rotating device which is atomized by centrifugal force as it leaves the periphery of the atomizer.
4. Kinetic energy sprayers – The spray liquid flows to a vibrating nozzle by gravity which generates a coarse fan shaped spray pattern.

On basis of power source, it is classified as follows:

a. Hand operated sprayers.
b. Power sprayers.

Hand Operated Sprayers

1. Hydraulic energy sprayers:

a. Stirrup pump sprayer: Spraying in orchards, vegetable gardens, flower crops and nurseries
b. Knapsack/Backpack sprayer: Spraying on row crops, shrubs and small trees
c. Rocker sprayer: Spraying on vegetable gardens, flower crops, orchards, vineyards and field crops, tall trees and crops like coconut, arecanut, sugarcane, etc.
d. Foot sprayer: All-purpose sprayer, both for small- and large-scale spraying of orchards, field crops, tea and coffee plantation, vegetable garden, flowers, nurseries, etc.

2. Compression/Pneumatic/Air sprayers:

a. Hand compression sprayer: Spraying on field crops, vegetable gardens, flower crops, nurseries, kitchen garden.
b. Compression knapsack sprayer: Good for large area spraying.

3. Gaseous energy/Air Blast sprayers:

Hand atomizer/Flint pump: Suitable for experimental work on individual plants.

Power Sprayers

1. Hydraulic energy sprayers:

a. Small portable Hydraulic sprayer: Spraying ground crops and orchards for small areas.
b. Large Hydraulic sprayers: Suitable for row field crops, orchards and plantation.

2. Pneumatic/Compression/Air energy sprayers:

a. Portable and small mounted sprayers: Not suitable for materials which sediment quickly

b. Large mounted sprayers: Suitable for all types of formulations, expensive, use limited to level lands only.

3. Gaseous energy sprayers:

a. Motorized Knapsack sprayers: Both for dusting and ultra-low volume spraying.

Safety in Handling of Equipment

1. Wear protective clothes while spraying.
2. Operators should avoid absorbing chemicals through the mouth, skin and nose
3. Do not eat or chew anything while spraying.
4. Care should be taken to avoid splashing of chemicals on skin while mixing these poisonous chemicals.
5. Spraying should not be done during windy weather.
6. Spray should be shut off while changing or cleaning nozzles
7. Children should be kept away from chemicals as well as from plant protection equipment.

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Avenues of Sex Pre-Selection in Domestic Animals

Article ID: 35088

Pawanpreet Singh[1], Rameez Ali[2], Anees A Shah[2]
[1]MVSc Scholar, SKUAST-Kasmir, [2]Assistant Professor, MLRI, Manasbal, SKUAST-Kashmir, Mountain Livestock research Institute, Ganderbal-193504, SKUAST-Kashmir.

Introduction

Sex ratio is the ratio of males to females in a population. Mammals usually produce approximately equal numbers of sons and daughters, but there are exceptions to this general rule. In most livestock species, offspring sex ratios do not differ significantly from 1:1. However, the offspring sex ratio can differ significantly due to some conditions and underlying mechanisms that prompt these changes. Sex manipulation technologies allow predetermination of the sex of animal offspring by altering the normal reproductive process. In livestock production, the difference in type and gender can translate into significant economic benefits, including alleviation of severe food shortages.

History

In ancient times, males were also preferred to girls since besides being more likely to appease, they were regarded to be a strong support for the elderly. The preference for producing male offspring therefore promoted sex manipulation research (Stévant *et. al.*, 2018). In the 1670's, Antoine Van Leeuwenhoek discovered a microscope which he used to observe sperm cells in human and dog seminal fluid. This discovery became a turning point in the research of sex manipulation (Ruestow *et. al.*,1983).

Nettie Maria Stevens in 1905 found that unlike in females, one chromosome was smaller than others in males. She concluded that the shorter chromosome was the "Y" chromosome, and was responsible for sex determination alongside the larger chromosome, which she named chromosome "X". Thereafter, the research on sex manipulation technologies gained traction with various studies seeking to enhance the respective existing technologies. Herein, we discussed the advances in sex manipulation technologies in animals with a focus of providing an informative insight for future development.

Factors Affecting Sex Ratio

1. Breed: Jersy sires have been reported to produce more females than Holstein sires (Foote, 1977), however breed appears to be a lesser factor as far as sex manipulation is concerned.

2. Parity: The sex ratio in primiparous animals appears be quite nearer to the general rule of 1:1, however, it is biased towards male offspring in multiparous cows. (Foote, 1977).

3. Maternal Nutrition: The prediction that females in better body condition would produce more male than female progeny has been observed in red deer, ewes, pigs and a number of other species. Dairy cows on a high plane of nutrition give birth to proportionately more bull calves than female calves. Repeat breeder cows, i.e., ones that have problems becoming pregnant by artificial insemination, also tend to produce more males [King *et. al.*, 1985].

4. Time of insemination: Early insemination favors the production of heifers, without impairing fertility; however, delaying artificial insemination favored the production of bulls, but with a significant reduction in fertility. In sheep, it was found that 60% of the offspring from ewes inseminated 5 h before ovulation were female, and 75% of offspring from ewes inseminated 5 h after ovulation were male. (Gutierrez-Adan *et. al.*, 1999)

5. Natural disaster: Although role of natural disasters in sex of newborn has not been studied extensively, however, a study revealed that there was decrease in male births compared to female births due to the earthquake (Saadat *et. al.*, 2008).

6. Environmental pollutants: Dioxins, PCBs, and furans, belong to a class of polyhalogenated aromatic hydrocarbons, which are persistent in the environment and have been recognized as having endocrine disrupting properties. A report revealed they dramatically reduced sex ratio of offspring born 9 months following the exposure in 1977–1984 to parents who lived in the most contaminated zone (Mocarelli *et. al*., 1996).

7. Climatic variation: A calf is more likely to be male than to be a female if it is born following periods of high air temperature, and or high evaporation which indicates that climatic factors that are associated with elevated temperatures and high evaporation might influence the offspring sex ratio in dairy cattle.

Techniques Used for Sex Pre-Selection

Sexing of spermatozoa: Out of various procedures available for preselection the most elegant method of alteration to separate X and Y spermatozoa is the sexing of spermatozoa. Spermatozoa are sexed on following principles:

1. Separation on the base of size and shape: The X-chromosome bearing sperm has been postulated to be necessarily larger than the Y- chromosome bearing sperm.

2. Separation on the basis of swim up: Laminar flow fractionation: Y-bearing spermatozoa swim differently and more quickly than X-bearing spermatozoa.

3. Predicting differences in surface charge:

   a. Free-flow electrophoresis: When semen is subjected to electrical field on an electrophoresis plate subpopulation of X- and Y-bearing spermatozoa should separate perpendicular to the electrical field according to their net electrical charges and difference in motility.

   b. Counter current galvanic separation: It involves the use of specially designed forced convection streaming galvanic cell which is claimed to enhance the separation of X-and Y-bearing spermatozoa.

4. Predicting differences in cell surface antigenic determinants: Histocompatibility-Y antigen (H-Y) is found in male tissues of many mammalian species with the exception of erythrocytes and premeiotic germ cells. If the expression of H-Y antigen on the surface of these haploid cells is due to expression of the Y-chromosome, then this could be used to separate HY+ spermatozoa.

5. Predicting the difference in DNA content: Sexing sperm by DNA content provides a means for predetermining the sex of calves with 85–95% accuracy. This sexing process, which is now commercialized at numerous sites worldwide, uses a flow cytometer/cell sorter to separate sperm according to their DNA content. X-chromosome-bearing sperm, which produce heifers, contain nearly 4% more DNA than Y-chromosome-containing sperm, which produce bull calves (Hasler and Garner, 2011).

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Spices as Immunity Boosters

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Sivakumar V[1], Srinivasulu A[2]
[1]Scientist (Hort.), Horticultural Research Station, Dr. YSRHU, Chintapalli, Visakhapatnam, A.P.
[2]Research Associate, Horticultural Research Station, Dr. YSRHU, Chintapalli, A.P.

India, the Land of spices is the largest producer, consumer and exporter of spices in the world. According to Spices Board, 52 spices are grown in the country. However, commercial cultivation is limited to about few crops *Viz*., chilli, turmeric, black pepper, cardamom, ginger, seed spices etc which have importance in the domestic as well as international trade (Nybe *et al*., 2007).

Spices are less volume more value crops which add taste to food, imparts characteristic aroma, flavor and they also well known as appetizers, preservatives. Some spices are natural tenderizers for meat. Spices also used as medicine for ages having been recognized to possess physiological effects beneficial to human health.

Most of the spices possess anti-oxidant, anti-microbial, anti-biotic, anti-inflammatory, anti-carcinogenic properties, so spices are called as functional foods. Due to the medicinal properties of spices, they offer lots of health benefits through copious essential oils, phyto-nutrients and other physiologic effects such as acting on the digestive system so, traditionally they have been used in Ayurveda and Chinese traditional medicine to cure several chronic ailments.

Each Spice crop contains Specific phyto nutrients which favour to improve health and increase immunity**.** With the rich source of phyto nutrients, Spices play a major role in human health by supplying as antioxidant, antimicrobial, anti-diabetic, anti-mutagenic and anti-carcinogenic, anti-inflammatory compound, as digestive stimulants, and so many other ways.

Table 1. Some of the specific phyto-nutrients available in Spice crops:

Spice crop	Phyto-nutrients	Spice crop	Phyto-nutrients
Chilli	Capsaicin	Nigella	Thymoquinone
Turmeric	Curcumin	Sweet flag	Acorin
Ginger	Gingerol	Aniseed	Anethole
Black pepper	Piperine	Nutmeg	Myricetin
Cardamom	Cineole	Coriander	Linalool
Clove	Eugenol	Saffron	Cicrocrosin
Asafoetida	Ferumine	Fenugreek	Diosgenin
Ajwain	Thymole	Cumin	Cuminol
Cinnamon	Cinnamaldehyde	Fennel	Limone

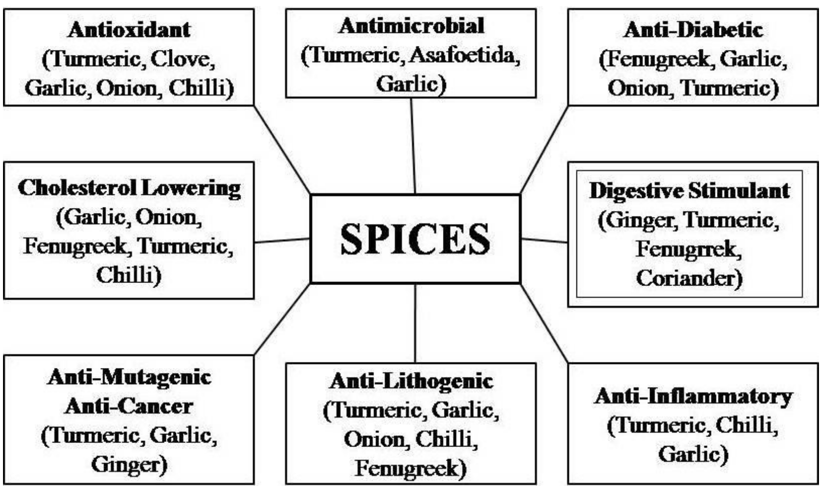

Fig 1. Several health benefits of Spices

Immunity plays an important role in defending against foreign invaders like bacteria, virus, fungi, toxins and parasites which cause seasonal outbreaks of infections like cold, cough, various types of fever. Boosting our natural immunity is the best way to stay healthy. Many herbs and spices have immunomodulating properties. All the spice crops have a broad range of bio-functions and their combined actions that protect the human body.

Black pepper can be used as pain relief, rheumatism, flu, normal cold, indigestion, etc and it is considered as an antimicrobial agent. Ginger is widely used as herbal medicine to treat different illnesses including fever, diabetes, liver disorders, bronchitis, high blood pressure, tuberculosis, sinus problems, etc,. Turmeric has been used for centuries to treat various disorders such as rheumatism, body ache, skin diseases, intestinal worms, diarrhea, intermittent fevers, constipation, urinary discharges, inflammations, dyspepsia, leukoderma, dental diseases, digestive problem such as indigestion, ulcers, dyspepsia, acidity and colic inflammatory disorders such as arthritis, colitis and hepatitis. Garlic has been used to treat fevers, liver disorders, diabetes, tuberculosis, rheumatism, dysentery and high blood pressure (Anupam *et al*., 2018). Likewise other spices also have significant health effect through act as anti-microbial, anti-inflammatory and anti-oxidant activities.

Free radicals are derived either from normal essential metabolic processes in the human body or from external sources such as exposure to X-rays, cigarette smoking, air pollutants, and industrial chemicals. Free radicals have a lifespan of only a fraction of a second, but during that time these can damage DNA, due to these mutations may occur in DNA that can lead to Oxidative stress. Oxidative stress has been linked to heart disease, heart stroke, cancer, arthritis, respiratory diseases, immune deficiency, parkinson's disease, aging and other inflammatory conditions. Antioxidants also called as Free radical scavenger present in our body can prevent damage to cells caused by free radicals by neutralize the unstable free radical molecules by transfer the electrons and convert into stable free radicals and reduce the risk of damage and this is thought to boost overall health by supporting kidney function, improves reproductive function, Improves nerve system functioning, Support the immune system & improve defense power of the body, Protect the liver, reduce obesity, Offer protection against digestive disorders, Maintain healthy vision, Support respiratory system and improve quality of sleep (Bagchi et al., 1998).

Antioxidant properties of spices have significant impact on oxidative modification of Low-Density Lipoprotein-cholesterol. The antioxidant properties of spices compounds are flavonides isolate, phenolic amides from black pepper; capsaicin, capsaicinol isolate from chilli eugenol, gallates get from clove; gingerol, diarylheptanoids isolate from ginger, curcumin is an active antioxidant get from turmeric (Pandey et al., 2014). Spices which have antioxidant property can act as anti-mutagens. Curcumin present in turmeric, sulfur compounds present in garlic have good anti-mutagenic properties. (Srinivasan, 2005). The foods having higher Oxygen Radical Absorption Capacity (ORAC) values may be more effective at neutralizing free radicals.

Table 2. ORAC values of commonly consumed food items:

Food Item	ORAC Values	Food Item	ORAC Values
Egg Whites	10	Cabbage, Boiled	856
Beef Steak - Meat	10	Cauliflower, Raw	870
Egg Yolk	20	Eggplant, Raw	932
Egg, Whole	20	Mangos, Raw	1300
Instant White Rice, Cooked	30	Broccoli, Raw	1510
Milk, 2% Fat	50	Red Grapes, Raw	1837
Fried Chicken without Skin, Frozen – Meat	60	Cashews, Nuts	1948
Fried Chicken with Skin, Frozen - Meat	50	Pomegranates, Raw	4479
Fried Chicken without Skin, Frozen - Meat	60	Garlic, Raw	5708
Fried Chicken with Skin, Frozen - Meat	50	Saffron Spice, Whole	20580
Honey	130	Paprika Spice	21932
Watermelon, Raw	142	Black Pepper Spice	34053
McDonald's Crispy Chicken Sandwich,	180	Ginger Spice, Ground	39041
Pizza Hut Cheese Pizza	170	Cumin Seed Spice	50372

Green Peas, Canned	120	Basil Spice, Dried	61063
Papaya, Raw	300	Allspice, Ground	100400
White Tea, Bottled	264	Dried Vanilla Bean	122400
Green Tea, Bottled	520	Turmeric Spice, Ground	127068
Oyster Mushrooms, Raw	664	Ground Cinnamon Spice	131420
Butter	730	Ground Cloves Spice	290283

Source: ORAC values database 2020.

Conclusion

Spices improve health and boost immunity of human by several ways as antioxidants, anti-mutagens, anti-inflammatory agents, anti-microbial, anti-viral, cancer preventive potential, etc. As each spice possesses multiple health benefits and there is also a prospect of synergy amongst them in the action when consumed in combination, a spiced food is probable to make life not only added 'spicy' but also healthier. Based on the present research evidences, there is lot of scope to conduct research on nutritive values of spices. Scientific and Clinical studies have to be conducted on uses of spices in improving human health must await more definitive scientific evidence. Such a move will assist in designing a global health strategy that is more robust, institutionalized, reasonable and sustainable.

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Active Packaging: Novel Food Packaging Technology

Article ID: 35090

Anchal Jaiswal[1]

[1]Agricultural Processing and Food Engineering, College of Agriculture and Research Station, Katghora, Chhattisgarh, 495445.

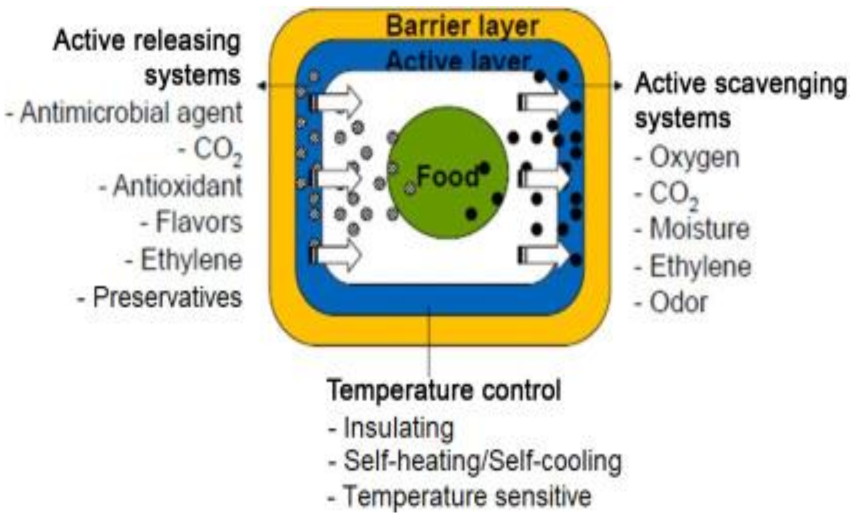
The dynamic growth of importance of packaging contributes to the continuous improvement of production methods and ways. Due to the growing consumer interest in consumption of fresh products with extended shelf life and controlled quality, manufacturers have to provide modern and safe packaging. Therefore, packaging producers are looking for solutions that allow improving such properties of packaging materials as: an adequate barrier to gases, UV protection, extension of the storage period, transparency, and environmental performance. It is a challenge for the food packaging industry and also acts as a driving force for the development of new and improved concepts of technology packaging. Active packaging is a solution, in which the packaging, the product and the environment interact.

Active Packaging

Packaging also meets the fundamental need to maintain food quality and safety from initial production to final consumption by preventing any unwanted deterioration in terms of chemical and biological changes. It helps in protecting against harsh external environmental factors like heat, light, presence or absence of moisture, pressure, microorganisms and gaseous emissions. Active packaging is a solution, in which the packaging, the product, and the environment interact. These are the systems, which (as a result of the chemical, physical, and biological activities) actively change conditions of the packed food, cause an extension of its sustainability and thus its shelf life, and guarantee or significantly improve the microbiological safety and/or sensory properties, while maintaining its quality. In this method of preservation of foods, chemicals need not be added directly to foods but can be used in the packaging materials with minimal harmful effects. Active packaging prolongs the storage life and enhances the margin of food safety by altering the condition of the food. Active packaging is used as a substitute to conventional food processing techniques (high thermal treatments, brining, acidification, dehydration and additive preservation).

Active packaging is one such technique that has help in keeping the food quality avoiding deterioration and consists of absorbers (active scavenging systems) and emitters (active releasing systems). Absorbers remove unwanted components that cause deteoration in the food from within and the surrounding environment whereas emitters are added compounds to the packaged food. The atmosphere inside packaging can be actively controlled by substances which absorb (scavengers) or release (emitters) gases.

Scavengers



Scavengers are designed to remove undesired components from the environment inside packaging. There is no direct migration between a scavenger and a product but only improvement of the conditions inside packaging, which prolongs a shelf life of the product. Depending on the application, it may be associated with the absorption of oxygen, moisture, ethylene, or carbon dioxide. It is in order to achieve specific effects that such substances as cellulose, activated carbon, silica gel, iron ions, ascorbic acid, potassium permanganate, and calcium hydroxide are applied.

Emitters

The principle of operation of emitters is based on releasing desired substances that have a positive impact on food into the packaging environment. Such packaging contains and produces compounds capable to get inside the packaging and inhibit adverse processes. They are intended to guarantee stable conditions during storage and should ensure extension of the shelf life. It is by means of emitters that humidity inside packaging (vegetable packaging) can be controlled, the growth of harmful microorganisms (emitters of CO_2, SO_2, and ethanol) can be inhibited, and bacterial spoilage can be prevented (antibacterials). Emitters can be fragrant substances, food additives, food ingredients, humidity regulators, and biological active substances, which prevent growth of microorganisms.

The principle behind active packaging is based either on the intrinsic properties of the polymer used in packaging material itself or the inclusion of Specific substances inside the polymer. Packaging may be termed active when it performs some desired role in food preservation other than providing an inert barrier to external conditions. It can also be defined as packaging that changes the condition of the packed food to extend shelf life or improve safety or sensory properties while maintaining the quality of packaged.

The Polymerase Chain Reaction (PCR): Cloning DNA in the Test Tube

Article ID: 35091

Dr. Varsha Kumari[1]

[1]Assistant Professor, Department of Plant Breeding and Genetics, SKN College of Agriculture, Jobner-303329, Jaipur, Rajasthan.

Introduction

PCR stands for the **Polymerase Chain Reaction** and was developed in 1985 by Kary Mullis and associates. PCR is capable of producing enormous amplification (*i.e.*, identical copies) of a short DNA sequence from a single molecule of starter DNA. It is a technique for quickly "cloning" a particular piece of DNA in the test tube (rather than in living cells like *E. coli*). By this technique, one can make virtually unlimited copies of a single DNA molecule even though it is initially present in a mixture containing many different DNA molecules. It is used to amplify a specific DNA (**target**) sequence lying between known positions (**flanks**) on a double-stranded (ds) DNA molecule. The amplification process is mediated by **oligonucleotide primers** that, typically, are 20-30 nucleotides long. The primers are single-stranded (ss) DNA that have sequences complementary to the flanking regions of the target sequence. Primers anneal to the flanking regions by complementary-base pairing (G≡C and A=T) using hydrogen bonding. The amplified product is known as an **amplicon** (Erlich *et al*., 1991).

Requirements

1. Thermal cycler.
2. PCR amplification mix typically containing.
3. Sample dsDNA with a target sequence.
4. Thermostable DNA polymerase.
5. Two oligonucleotide primers which are complementary to the sequence flanking the target sequence.
6. Deoxynucleotide triphosphates (dNTPs).
7. Reaction buffer containing magnesium ions and other components.

Stages

Heat denaturation: A DNA molecule carrying a target sequence is denatured by heat at 90-95ºC. The two strands separate due to breakage of the hydrogen bonds holding them together.

Primer annealing: In the presence of an excess of dNTPs (the 'building blocks' of new DNA material), oligonucleotide primers are added. The primers are complementary to either end of the target sequence but lie on opposite strands. As the mixture cools at a lower temperature (50-65ºC), each strand of DNA molecule becomes annealed with an oligonucleotide primer complementary to either end of the target sequence.

Primer extension: DNA polymerase is then added and complementary strands are synthesized at a temperature of 60-75ºC. The polymerase causes synthesis of new material in the 5' to 3' direction away from each of the primers. Following primer extension, the mixture is heated (again at 90-95ºC) to denature the molecules and separate the strands and the cycle repeated. Each new strand then acts as a template for the next cycle of synthesis. Thus, amplification proceeds at an exponential (logarithmic) rate, *i.e*. amount of DNA produced doubles at each cycle.30-35 cycles of amplification can yield around 1**μ**g DNA of 2000bp length from 10^{-6}**μ**g original template DNA. This is a million-fold amplification! Initially the 3 different stages at 3 different temperatures were carried out in separate water baths but nowadays a thermal cycler is used (a machine that automatically changes the temperature at the correct time for each of the stages and can be programmed to carry out a set number of cycles) (Darnell, 1993) Figure 1.

A typical thermal cycle might be as follows:
1. Heat denaturation at 94ºC for 20 seconds.
2. Primer annealing at 55ºC for 20 seconds.

3. Primer extension at 72ºC for 30 seconds.

Total time for one cycle = approx. 4 minutes (You can't simply add up the different times for the stages above because heating and cooling between each stage also have to be considered)

Following PCR, the amplification product can be detected using gel electrophoresis where visualization of a band containing DNA fragments of a particular size can be indicate the presence of the target sequence in the original starter DNA sample. Similarly, absence of a band may indicate that the target sequence was not present in the original starter DNA sample. In this way, PCR can be used in combination with other techniques to not just simply amplify DNA (which, in essence, is all it does!) but also to detect specific target sequences (Read *et al.*, 1997).

PCR can be an extremely sensitive technique but is prone to contamination (unless scrupulous precautions are taken) leading to false positive results.

The Procedure

1. In order to perform PCR, you must know at least a portion of the sequence of the DNA molecule that you wish to replicate.
2. You must then synthesize **primers**: short oligonucleotides (containing about two dozen nucleotides) that are precisely complementary to the sequence at the 3' end of each strand of the DNA you wish to amplify.
3. The DNA sample is heated to separate its strands and mixed with the primers.
4. If the primers find their complementary sequences in the DNA, they bind to them.
5. Synthesis begins (as always 5' -> 3') using the original strand as the template.
6. The reaction mixture must contain:
    a. All four deoxynucleotide triphosphates (dATP, dCTP, dGTP, dTTP)
    b. A DNA polymerase. It helps to use a DNA polymerase that is not denatured by the high temperature needed to separate the DNA strands.

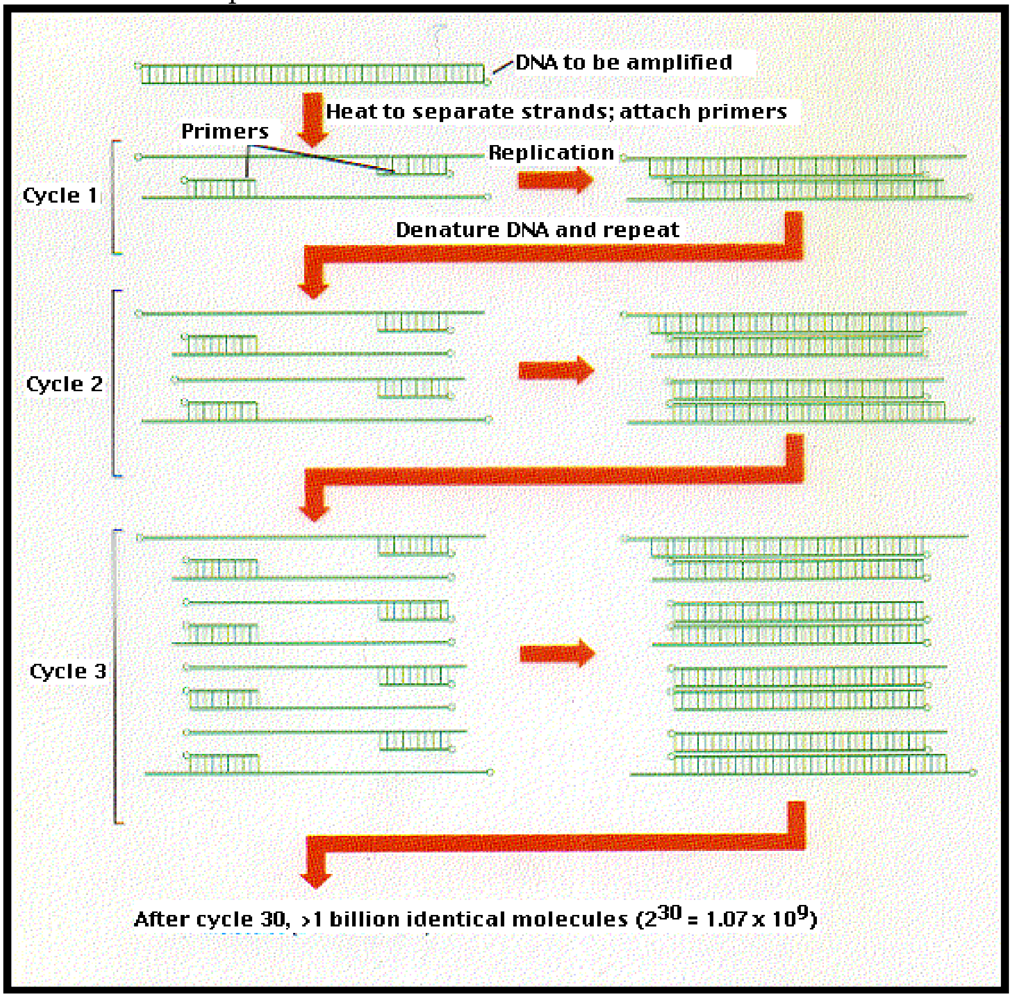


Figure 1: Procedure of polymerase chain reaction

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Restriction Endonucleases

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Dr. Varsha Kumari[1]
[1]Assistant Professor, Department of Plant Breeding and Genetics, SKN College of Agriculture, Jobner-303329, Jaipur, Rajasthan.

Introduction

Restriction Endonucleases: A restriction enzyme (or restriction endonuclease) is an enzyme that cuts DNA at or near specific recognition nucleotide sequences known as restriction sites. Restriction enzymes are commonly classified into three types, which differ in their structure and whether they cut their DNA substrate at their recognition site, or if the recognition and cleavage sites are separate from one another.

To cut DNA, all restriction enzymes make two incisions, once through each sugar-phosphate backbone (i.e., each strand) of the DNA double helix. These enzymes are found in bacteria and archaea and provide a defense mechanism against invading viruses.

Inside a prokaryote, the restriction enzymes selectively cut up foreign DNA in a process called restriction; while host DNA is protected by a modification enzyme (a methylase) that modifies the prokaryotic DNA and blocks cleavage. Together, these two processes form the restriction modification system (Galburt and Stoddard, 2000).

Over 3000 restriction enzymes have been studied in detail, and more than 600 of these are available commercially. These enzymes are routinely used for DNA modification in laboratories, and are a vital tool in molecular cloning.

These enzymes occur naturally in bacteria as a chemical weapon against the invading viruses and cut both strands of DNA when certain foreign nucleotides are introduced in the cell. These enzymes cleave a DNA to generate a nick with a 5' phosphoryl and 3' hydroxyl termini.

There are two major restriction enzymes: Type I and Type II. Type of enzymes recognize a specific sequence of DNA molecule but cut elsewhere, and Type II make cuts only within the restriction sites and produce two single strand breaks, one break in each strand. Type II enzymes are the most important ones. As a result of their action the broken nucleotides form a DNA duplex which exhibit two-fold symmetry around a given point. In some cases, cleavage in two strands is staggered to produce single stranded short projections opposite to each other with blunt or mutually cohesive sticky ends which are identical and complementary to each other.

These complementary sequences are also known as palindrome sequences or palindromes. Therefore, when read from 5' 3' both strands have the same sequence. Nowadays a large number of restriction enzymes are available commercially. Some of the commonly used restriction endonucleases are given in.

Roberts (1983) has given an extensive list of restriction enzymes and the sequences recognized by them. Most of the enzymes share a common central nucleotide in their recognition sequence for example, BamHI, BglII, and Sau3A.

But these enzymes recognize different sites in DNA and produce identical single stranded 5' tails which allow the joining of fragments generated by different enzymes within this set. The identical nature of the termini of cleaved DNA fragments from any organism is the very property which permits the annealing and subsequent ligation of the DNA from diverse sources (Pingoud *et al.*, 2005).

There are many enzymes which are used in genetic engineering as an important biological tool; some of them are described below:
Exonucleases: These enzymes act upon genome and digest the base pairs on 5' or 3' ends of a single stranded DNA or at single strand nicks or gaps in double stranded DNA (Fig. 1).
Endonucleases: They act upon genetic material and cleave the double stranded DNA at any point except the ends, but their action involves only one strand of the duplex (Fig. 1).

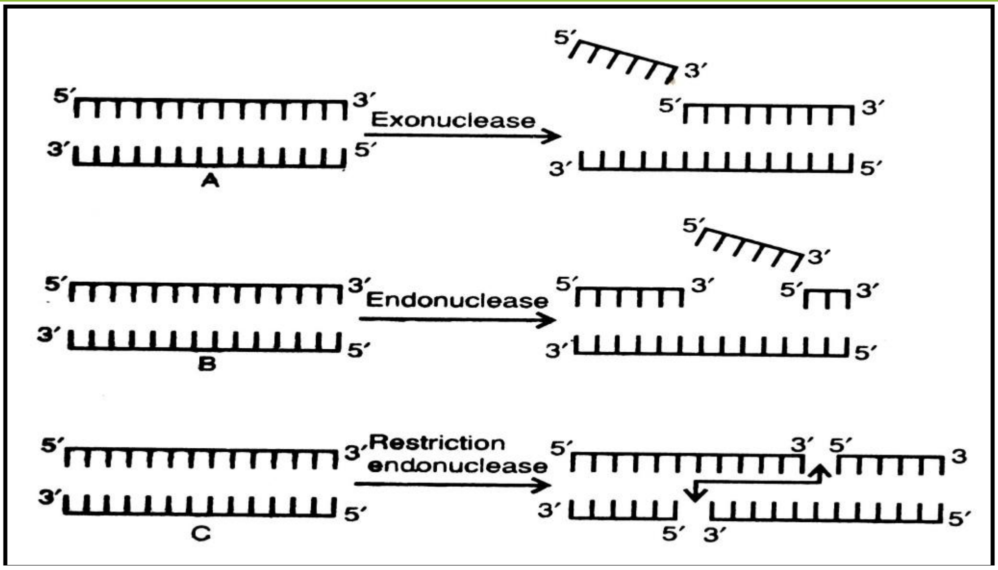

Fig 1: Restriction Endonuclease and Exonucleases

Nomenclature of Restriction Enzymes

The restriction enzymes are named based on some of the following principles (Table 1):

1. Name of the organism is identified by the first letter of the genus name and the first two letters of the species name to form a three-letter abbreviation in the italic, for example, *E. coli* = *Eco* and *H. influenzae* = *Hin,* etc.
2. A strain or type identified is written as subscript *e.g., EcoK* for *E. coli* strainK, *Hind* for *H. influenzae* strain Rd.
3. In such cases where the restriction and modification systems are genetically specified by a virus or plasmid, the extra chromosomal element is identified by a subscript *e.g., Eco* RI, *Eco*PI*,* etc.
4. When a strain has several restriction and modification systems, these are identified by Roman numerals, for example *Hindi, Hindll, Hindlll* for *H. influenzae* strain Rd. etc. These Roman numerals should not be confused with those in the classification of restriction enzymes into Type I (Kirsanova *et al*., 2004).

Table 1: Source of restriction enzymes, cleavage sites and productions of cleavage:

Microorganisms	*Restriction enzymes*	*Cleavage sites*	*Cleavage products*
Bacillus amyloliquefaciens H	*Bam* HI	5-GGATCC-3 3-CCTAGG-5	5-G GATCC-3 3-CCTAG G-5
B. globigii	*Bgl* II	5-AGATCT-3 3-TCTAGA-5	5-A GATCT-3 3-TCTAG A-5
Escherchia coli RY13	*Eco* RI	5-GAATTC-3 3-CTTAAG-5	5-G AATTC-3 3-CTTAA G-5
Haemophilus influenzae Rd	*Hin* dIII	5-AAGCTT-3 3-TTCGAA-5	5-A AGCTT-3 3 -TTCGA A-5
H. parainfluenzae	*Hpa* I	5-GTTAAC-3 3-CAATTG-5	5-GTT AAC-3 3-CAA TTG-5
Klebsiella pneumoniae OK 8	*Kpn* I	5-GGTACC-5 3-CCATGG-3	5-GGTAC C-3 3-C CATGG-5
Streptomyces albus G	*Sal* I	5-GTCGAC-3 3-CAGCTG-5	5-G TCGAC-3 3-CAGCT G-5
Staphylococcus aureus 3AI	*Sau* 3AI	5-GATC-3 3-CTAG-5	5- GATC-3 3-CTAG 5

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Silica Nutrition to Crops – Challenge to Criteria of Essentiality of Nutrients

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Rajakumar D.[1], M. Gomathy[1], K. G. Sabarinathan[1]
[1]Agricultural College and Research Institute, Killikulam – 628 252, Thoothukudi District, Tamil Nadu.

Summary
Though silicon is not considered as an essential element for crop production, its essentiality is proven beyond doubt in many of the agricultural crops especially those belonging to *Poaceae* family. Specifically, it plays a beneficial role in mitigating the harmful effects of biotic and abiotic stresses and thereby increasing the productivity. The ambiguity in finding the exact role they play in plant metabolic activities are underway with the scientific and research advancements.

Introduction
Silicon (Si), the unique mineral is ubiquitous in nature as a constituent of the Earth's crust. It is available plentiful naturally in the earth next to oxygen. Silicon does not exist as a free element in nature. It always exists as a mineral in combination with other elements and mostly as silica (SiO_2) in combination with oxygen. Due to chemical and physical weathering, Si is released in soil solution, which is absorbed by the plants. Regarding the essentiality of silica for crops, the debate is underway since 19th century. Silicon has not been categorized under essential element for higher plants as per the 'Criteria of essentiality of nutrients', but as a beneficial element, its influence on growth under stress conditions have been reported in many crops.

Uptake of Silica by Plants
Majority of Si compounds in the soil consists of silicon dioxide, silicate minerals and aluminosilicates, which are not available for plant uptake. The only available form of silicon compound is monosilicic acid or orthosilicic acid, but the concentration of this bioavailable form is meagre in the soil. Even if the Si concentration is higher in soil solution, polymerization of monosilicic acid into oligomeric and polymeric silicic acids and complexes with organic compounds occur thus resulting in an insufficiency of monosilicic acid in the soil. Again, the presence and solubility of macronutrients, primary and secondary minerals is an important criterion in the availability of Si from soil solution.

Removal of Silica by Crops
Every plant in the universe contains Si at different concentrations according to the respective species which may range between <0.1 and >10.0 per cent on dry weight basis. Accordingly, plants can be classified as "accumulators" which have a Si concentration over 1 per cent and "excluders" which have a Si concentration below 0.5 per cent. Plants that do not fall under the above category are called "intermediates". The variation in Si concentration in plants is due to their differential silica absorbing ability. Though Si is not limiting in soils, crops like sugarcane can take up Si as high as 300 to 500 kg ha^{-1} year^{-1} (Anderson *et al.*, 1991) and 500 kg ha^{-1} year^{-1} by rice (Makabe *et al.*, 2009). The removal of silica from soil is thus aggravated in situations of crop intensification and monocropping especially with silica accumulating crops like rice and sugarcane wherein the Si bioavailability and recycling is disrupted.

Benefits of Silica
Plant growth depends on several nutrient elements existing in the soil which can be grouped as beneficial, essential and toxic. Essential elements are those which play vital roles in all metabolic activities of plant under different growth stages. Whereas, beneficial elements are vital for some specific plant species growing under certain growth situations only. As early as the 19th century, the beneficial effects of Si and its key role in mitigating various abiotic and biotic stresses has been experimented and proven firmly since Si plays a key role in improving plant growth, mechanical strength and resistance to pathogens and

herbivory. Lodging is a problem in rice from time immemorial and Si found to improve resistance to lodging by providing strength to the stem. Under water scarce situations, it induces the formation of a silica cuticle under the leaf epidermis and reduces water loss through transpiration. Apart from that silicon deposition increases abrasiveness of plant tissues thus reducing palatability and digestibility for herbivores thereby protects the crops from insect pests.

Conclusion

It is high time to challenge the conception that 'Si as a non-essential nutrient' since it is found to influence the growth and yield of many crops even those are not classified as Si accumulators. Though the essentiality of this element to plants is still under debate, researches in the line of Si uptake and utilization have drawn attention in the recent past with the advent of identification of Si transporters in few crops like rice, maize, barley, wheat and soybean. Moreover, among the researchers, role of Si and its beneficial effects of supplementing the crops with Si has gained importance, particularly with regard to plant stress management.

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Novel Approaches for Classification of Insects

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Y. Peeru Saheb[1], K. Manjula[2], Archana Anokhe[3]
[1&2]Department of Entomology, S. V. Agricultural College, Tirupati, Andhra Pradesh.
[3]Indian Agriculture Research institute, New Delhi.

Insects are the most abundant of all life on earth and have evolved into a tremendous range of different forms. Conventional Entomological identification is based on morphological features. These are highly difficult, time consuming and may even prove impossible. Alternative method for identification is use of molecular techniques (Maite *et al*., 2013).

Classification of insects is scientific arrangement of organisms in a hierarchy series of groups. Classification is an attempt to impose an order on confusing diversity of organisms so as to group like organisms together. Hundreds of years attempts to classify the organisms were made until the species was recognized as primary unit of taxonomy, the basis of modern classification. Identification and classification of organisms involve their habits, habitats, structures, life cycles (Dhaliwal *et al.,*2012). Techniques currently used to provide molecular characters for insect taxonomy and systematic are as followed Cuticular hydrocarbons, Allozymes, Karyotypes, RFLP, (RAPD)DNA, AFLP, Microsatellites, Direct nucleotide sequencing, SNPs, ESTs and Microarray (Sperling and Roe, 2009). Microsatellite genetic analysis of one pupa and four adult specimens reared from an exotic Chinese crabapple indicated that the unidentified specimens were *Rhagoletis indifferens* and not *Rhagoletis pomonella* or *Rhagoletis zephyria* (Jean *et al.,* 2013). Differentiated four species of blow flies (Dipterans) *Peckia* (*Peckia*) *chrysostoma*, *Peckia* (*Peckia*) *intermutans,* *Sarcodexia lambens* and *Sarcophaga* (*Liopygia*) *ruficornis* based on cuticular hydrocarbon composition using Gas Chromatography- Mass Spectrometer (Braga *et al*., 2013).

Insect recognition and classification to be carried out more efficiently have become pressing. Image-based technology is used to improve the shortcomings of the traditional method such as manual identification of insects by the experts as well enhancing accuracy and saving time. Colour Histogram and GLCM, Hybrid Approach, stacked spatial- pyramid kernel, Ontology based insect recognition, KNN- Spectral regression LDA, Histogram of local appearances features. Among the methods used, color histogram seems to be the best approach in classifying and recognizing species of insects. This is because the color histogram is using SIFT extraction feature to describe the image of the insect to be recognized. Each image acquired is divided into several squares similar in size and each of the square of images has its own histogram (Siti *et al.,* 2014). Recent focus on mtDNA-based identification, as DNA barcoding, has raised hopes that molecular methods will lift the perceived burden of biodiversity identification at the species level. Growing tendency for insect molecular scientists to reach out to the broader molecular biology community just begun to see the positive impacts of the molecular biology toolbox on basic and applied insect science; the best is yet to come (Sperling and Roe, 2009).

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Role of Humic Acid in Plant Growth Enhancement

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Venkatesh Bathula[1], N. Vinod Kumar[1], S. Vaishnav[1]
[1]Department of Agronomy, College of Agriculture, PJTSAU, Rajendranagar, Hyderabad, Telangana-500 030, India.

Introduction

There is a growing interest in the development and implementation of more sustainable land management practices, aiming to stop the progressive degradation of soils while maintaining or enhancing food production in a context of increasing demands.

Among the different strategies, the use of humic-based soil amendments constitutes an environmentally friendly approach. Many studies have shown that humic substances (HS) from different origins applied to plant roots can improve plant growth and mineral nutrition. These positive effects involve various mechanisms, including the action of HS on soil and rhizosphere properties, as well as their interactions with plant roots.

Especially in rainy season due to continuous rains most of nutrients are get leached out, in order to supply required quantity of nutrient through the humic acid is the best option. The use of humic acid (HA) is a promising natural resource to be utilized as an alternative for increasing crop production. It is a naturally occurring polymeric organic compound and is produced by the decay of organic materials and is found in soil, peat and lignites.

Taking advantage of the complexing properties, various micronutrients are further complexed with HA to form chelates. Humic acids have been complexed with sodium (Na), potassium (K), magnesium (Mg), zinc (Zn), calcium (Ca), iron (Fe), copper (Cu), and with various other elements to overcome a particular element deficiency in soil. Humic acid serves as a catalyst in promoting the activity of microorganisms in soil.

Humic acid had beneficial effects on nutrient uptake by plants, and was particularly important for the transport and availability of micronutrients. Hypotheses which account for the stimulatory effects of HA are numerous, the most convincing of which is a ‘direct’ action on the plant, which is hormonal in nature, together with an “indirect action” on the metabolism of microorganisms and the dynamics of uptake of soil nutrients, substrate physical conditions through positive effects on seed germination, seedling growth, root growth, and shoot development.

Methods of Application of Humic Acid and Dosage

There are three methods by which humic acids applied through foliar, soil applications and drip irrigation.
1. In Soil Applications: Mix 5 liters of humic acid in 150 liters of water (1:30 ratio) for one acre of land. Apply the mixture while ploughing/seedling along with the application of fertilizers as usual. Repeat the same dosage before flowering.

2. In Foliar Applications: For one acre mix 1 liter of humic acid in 50 liters of water and spray to all crops before flowering. for ornamental plants and grass lawn spray the mixer once in 30 days in the morning/evening.

3. Drip Irrigation: Mix 5 liters of humic acid in 250 liters of water (1:50 ratio) for one acre of land. Apply the mixture with normal application of fertilizers in fertigation tank/ventury. For short period cultivation repeat the process before flowering. For long period cultivation repeat the process in 45 days.

For all field crops 4 liters/acre plus 50 times of water (200 liters) after emergence at 4-6 leaves stage, 6 liters/acre plus 50 times of water (300 lietrs) before flowering. Whereas, for orchard crops 1 ml per sapling, 5 ml per medium grown plant and 10 ml per grown up plant with 30 times of water and apply every 45 days.

Benefits of Humic Acids

The benefits of humic acid can be grouped into 5 main categories:

1. Physical.
2. Chemical.
3. Biological.
4. Economical.
5. Ecological.

Physical Benefits

Humic acids modify the physical structure of the soil which produces the following benefits:

1. Improves soil structure:
    a. Light sandy soils: humic acids increase soil's nutrient and water holding capacity by coating sand particles, preventing high water and nutrient losses while transforming unproductive soils into fruitful soils by way of decomposition. They hold water and nutrition in plant available forms at root zone and provide to plants as needed.
    b. Heavy and compact soils (clay): helps soil to loosen, creating looser crumbly soil, which: improves the penetration of nutrients, plant roots and water into the soil; increases aeration of soil, water retention capacity and improves soil workability.
2. Increases water holding capacity of soil.
3. Improves drought resistance of soil.
4. Darkens colour of soil, which helps in absorption of the sun's energy.

Chemical Benefits

Humic acids chemically change the fixation properties of the soil. Humic acid neutralizes acidic and alkaline soils; regulates pH-value of soils, increasing their buffering abilities; and has extremely high cation-exchange properties.

1. Improves and optimizes uptake of nutrients and water holding capacity
2. Stimulates plant growth with its rich organic and mineral substances
3. Helps to retain water soluble inorganic fertilizers in the root zones
4. Enhances the uptake of nitrogen by plants
5. Reduces the availability of toxic substances in soils.

Biological Benefits

Humic acids biologically stimulate plants and activities of micro-organism which encourages the following benefits:

1. Stimulates plant enzymes and increases their production.
2. Stimulates growth and proliferation of desirable micro-organisms in soil.
3. Enhances plant's natural resistance against diseases and pest.
4. Stimulates root growth, especially vertically and enables better nutrient uptake.
5. Increases vitamin and mineral content of the plants.
6. Thickens cell walls in fruit and prolongs their storage and shelf time.
7. Increases germination and viability of the seeds.
8. Stimulates plant growth.
9. Increases quality of produce: improves their physical appearance and nutritional value.
10. By just using fertilizers, we can't reach maximum crop yields. Maximum yields require organic matter humic acid, high cation exchange capacity and biological activity.
11. Soil pH affects many chemical and biological reactions. It is an important parameter for plant nutrition – in high acidity, absorption of nutrients such as nitrogen, phosphorus, potassium, sulphur, calcium diminishes; in high alkaline conditions, absorption of iron, manganese, boron, copper and zinc decreases.
12. Humic acid buffers soil pH to 5.5 to 7.5 levels which is ideal for plant development and nutrients absorption. Thus, acting as a natural chelator, they help plant roots to absorb nutrients more efficiently to create long term positive effect on soil quality and productivity. In comparison, conventional chemical fertilizers only show short term effects without any plus benefits on soil structure and soil productivity.

Economic Benefits

Humic acids chelate nutrient compounds in the soil, especially iron, to a form suitable for plant utilization, optimizing the plant's nutrient supply. This promotes:

1. Up to 70% increase in yield, accompanied by a reduction of up to 30% in the use of fertilizers and pesticides.
2. Better and healthier growth of green grass, ornaments, agricultural crops and woods with the regular application of quality humic acids.
3. Increased water holding capacity of soils, substantially reducing the use of water.

Ecological Benefits

The ecological benefits of humic acids are diverse and offer effective solutions for environmental issues and the preservation of the environment.

1. Reduces water contamination:
    a. Soils with a high content of humic acids encourage low nitrate leaching and optimum nutrient efficiency. A well-developed root system, which is achieved by high content of humic acids, prevents nitrate and pesticides from mixing in with ground water.
    b. Often growers use more fertilizers than plants can take up. This leads to nitrate concentration in the soil, which is later found in ground water, causing water contamination.
2. Humic acids reduce over-salination problems in application of water-soluble mineral fertilizers.
    Humic acids are able to decrease high salt contents in soils and resulting toxicities. Especially the NH4-toxicity of fertilizers containing ammonia is reduced, which is of great importance for young plants. Generally, humic acids reduce root burning which comes about through excessive salt concentrations in soils after fertilization. Also, when humic acids are mixed with liquid fertilizers, the undesirable smell is diminished.
3. Humic acids are an effective means to fight against soil erosion.
    This is achieved by increasing the ability of soil colloids to combine and by enhancing root system and plant development.

Conclusion

Using humic acid can be considered as a way to enhance nutrients uptake instead of using high nutrients concentration. Soil specific problems are easily overcome by humic acid application and for optimum yields with quality products are depends upon soil health which intern related to the soil microbial activity enhanced by humic acid. All soil physical, chemical and biological properties are interrelated with single application of humic acid we can cure the all problems.

Host Plant Resistance Against Nematodes

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S. P. Deepa[1], K. Sankari Meena[2]
[1]Assistant Professor, Department of Nematology, J. K. K. Munirajah College of Agricultural Science, T. N. Palayam, Gobi, Erode.
[2]Scientist (Nematology), Crop Protection Division, ICAR-Indian Institute of Oilseeds Research, Hyderabad, Telangana, India.

Summary
Resistance to plant parasitic nematodes has been described as the characteristics of host plant which act more or less to the detriment of the parasite (Rohde, 1965). Such resistance is usually recognized as either resistance to the nematode and its development or resistance to the disease caused by the nematodes. Host plant resistance can be evaluated based on the reproductive potential of the parasites on the host, rather than on the capability of the host to overcome the attack or to withstand the injury of the parasite (Rohde, 1972).

Introduction
The prospects for major contributions to protect world food production through crop resistance to nematodes are truly exciting. Agricultural scientists consistently identify the plant resistance as the highest research priority for nematode pest management. The advantages and benefits of breeding crop plants resistant to injurious parasitic nematodes and growing them on infested land, are many and varied. Resistant crops provide an effective and economical method for managing nematodes in both high and low value cropping systems. In case of annual crops, resistant crops can reduce nematode populations to levels that are non-damaging to the subsequent crops, thereby enabling shortening and modification of rotations. They are environmentally compatible and do not require specialized applications, as opposed to most chemicals and do not require an additional cost input or deficit. In less developed countries and in low value crops, plant resistance is probably the most viable solution to nematode problems.

Nematode Resistant Genes
Plants are defined as resistant to nematodes when they support reduced levels of nematode reproduction. Nematode resistant genes are present in several crop species such resistance genes have been mapped to chromosomal locations or linkage groups. Some of the resistant genes available against nematodes are:
Hs1pro-1: The first nematode resistance gene to be cloned is *Hs1pro-1*, a gene from a wild relative of sugarbeet that confers resistance against *Heterodera schachtii*, the beet cyst nematode (Cai *et al*., 1997).

Mi-1: The *Mi* gene of tomato confers effective resistance against several root knot nematode species. This gene was introduced into cultivated tomato, *Lycoperisicon esculentum*, from the wild species *L. peruvianum* by embryo rescue of the interspecific cross (Milligan *et al*., 1998).

Gpa2: *Gpa2*, a gene that confers resistance against some isolates of potato cyst nematode *Globodera pallida*, was cloned by a positional cloning strategy recently (Gururani *et al*., 2012).

Understanding Virulence in Nematodes
Intraspecific genetic variation in host range and response to specific resistance genes can be high in plant parasitic nematodes, especially sexually reproducing species such as *G. rostochiensis* and *H. glycines*. Controlled genetic crosses between inbred *G. rostochiensis* lines have demonstrated that a gene-for-gene relationship exists between the *H1* resistance gene in potato and a dominant avirulence gene (recessive parasitism gene) in the nematode.

The three most damaging root-knot nematode species (*M. incognita*, *M. javanica* and *M. arenaria*) reproduce asexually by mitotic parthenogenesis. Populations of root-knot nematodes that are able to reproduce (are virulent) on plants carrying *Mi* have been identified, both in unselected field isolates and after selection of avirulent populations, on resistant plants in the greenhouse (Williamson and Amar Kumar, 2006).

Resistance-Breaking Biotypes in Tomato

All resistance to root-knot nematodes present in commercial varieties of tomato is conferred by *Mi* gene. This gene confers resistance to three species of root-knot nematodes, *M. arenaria, M. incognita* and *M. javanica* (Isgouhi *et al.*, 1996).

Although *Mi* confers resistance to the three economically important species of root-knot nematode, it does not confer resistance to *M. hapla.* In addition, the resistance conferred by *Mi* is not effective in soils where temperatures rise above 28°C. Also, some isolates of *M. incognita* and *M. javanica* have been reported to cause galls and to reproduce on plants containing *Mi.* Since, *Mi* gene does not confer resistance to *M. hapla*, adult females of the nematode were diagnosed for isoenzyme electrophoresis analysis (Zwart *et al.,* 2019).

Resistance Breaking Population of *M. arenaria* on *Vitis* Spp.

Meloidogyne spp. is a very common pest of grapevines, *Vitis* spp. New damaging pathotypes or biotypes of this pest are a common occurrence, especially when rootstocks with only partial resistance are used and resistance-breaking populations are preferentially selected from the normal population. Using a 2-year field exposure screen, the population of *M. arenaria* isolated from resistant Harmony grape rootstock was found to break root knot nematode resistance of every rootstock challenged.

Studies were conducted on the nematode developmental rates of a single resistance-breaking population of *M. arenaria* in roots of partially resistant Teleki 5C and RS-9 compared to the susceptible Cabernet Sauvignon. *Meloidogyne* J2 usually penetrate roots of resistant cultivars, as in the case of resistant grape rootstock Teleki 5C. Penetration and developmental life stages of a resistance-breaking population of *Meloidogyne arenaria* in roots of Cabernet, RS-9, and Teleki 5C grape rootstocks, 4 to 35 days after inoculation was studied. The roots of Teleki 5C and Cabernet contained several times more J2 than RS-9. In Cabernet, most of the J2 were located in galls; in the other two rootstocks, fewer J2 migrated into the developing vascular cylinder and fewer feeding sites were induced (Anwar and McKenry, 2002).

Variation in Virulence of *Meloidogyne Incognita* Race 1, 2, 3 and 4 on Cowpea Genotypes

Meloidogyne incognita Races (1, 2, 3 and 4) were evaluated for virulence against widely grown resistant cowpea. Based on reproduction and root galling, the resistant cowpea genotype, Acc 64298, sustained its resistance to three (Race 1, 3 and 4) (RF = 0.58 -0.74, GI = 0.80 – 1.40) of the four races (Race 1, 2, 3, and 4) tested but broke down to Race 2. The incidence of resistance breaking of Race 2 poses problems to screening / breeding for nematode resistance.

Meloidogyne incognita Race 2 showed high virulence on the reference resistant genotype Acc 64298, with significant higher reproduction factor (RF) = 3.77, higher (root gall index (GI) = 4.60) higher (egg mass index (EMI) = 4.20) than those of other Races (Race 1, 3 and 4) with RF of 0.58 – 0.74, GI of 0.80 – 1.40, and EMI of 0.80 - 1.40 showing low virulence.

The high virulence of Race 2 on the resistant genotype and together with race 1, 2 and 3 on other cowpea genotypes may be due to inherent compatibility of the races with the genotypes that generates favourable virulent reaction that leads to high reproduction and damage in the genotypes. This may be consequent upon low level of β-glucosidase in the nematode (Race 2) thereby liberating low quantities of toxic phenols in the resistant and other genotype with minimal toxic effect on the nematode.

The races might as well have evolved the ability to modify the biochemical processes in the cowpea genotypes to allow provision of nourishment for the optimal development and reproduction of the nematode with consequential injury on the genotypes (Olowe, 2010).

Resistant-Breaking Biotypes in Cotton

Resistance-breaking populations of *Meloidogyne* spp. have been found to arise following continual exposure to plants referred to as resistant. Selection of more virulent populations of *M. incognita* through continued planting of resistant cotton occurred in California. In these cases, isolates with the highest level of reproduction on the resistant cultivar NemX were found in fields previously planted to this source of resistance. Experiments were conducted to compare the reproduction of four populations of *M. incognita* on six upland type cotton cultivars including an advanced breeding line, CIM-534, as well as an F1 irradiated resistant line, NIAB-78.

Two populations of *M.incognita* including MI-78 as the virulent and MI-534 as the avirulent. The root systems were rated for galling and egg mass presence on a 0 to 5 scale. Development and reproduction of four populations were studied on the roots of NIAB-78, the poorest host for the four nematode populations. Equivalent numbers of J2 penetrated roots of NIAB-78 regardless of the population evaluated. The presence of small giant cells and galls on roots of NIAB-78 infected by populations MI-534, MI-496 and MI-506. Similar numbers of J2 in roots of resistant and susceptible cotton cultivars indicate that genetically controlled barriers to root penetration had failed to halt the entry of J2 into the roots of resistant NIAB-78 cultivars. Even on the most resistant of these cotton cultivars, there continues to be nematode feeding, giant cell formation, galling and reproduction.

Resistance-Breaking Biotypes of Burrowing Nematode

The citrus rootstock, Carrizo citrange (Citrus sinensis), is used as a resistant rootstock and planted in orchards to overcome citrus decline. However, the seedlings were inconsistent with respect to resistance to certain biotypes of the burrowing nematode. Aggressive nematode populations have been detected that are capable of overcoming the rootstock resistance. Three biotypes, namely Biotype 1, 2a and 2b were found to occur in the seedlings, under greenhouse conditions. Moreover, spreading decline symptoms have also found to occur on the Carrizo seedlings after infestation by the burrowing nematode (Mahfouz and Abd-Elgawad, 2020).

Future Perspective

Resistance-breaking strains are becoming more widespread and ignored, cosequences can be catastrophic. Repeated planting of resistant varieties allows only the reproduction of resistance-breaking nematodes until a large enough population exists to cause damage to the crop. Investigations of cloned *R* genes are likely to lead to increased understanding of the molecular mechanisms by which resistance is produced. This understanding may allow development of designer *R* genes with faster response, broader or different target recognition or increased durability. Such developments will need to be coupled with investigation of the mechanisms by which nematodes circumvent resistance. Understanding the interactions between host and pathogen will increase options for control strategies as our ability to use chemical pesticides decreases and the need for food production continues to increase. A variety of strategies to engineer synthetic resistance are being developed. Strategies that combine one or more natural resistance genes with synthetic resistance may be the most effective in overcoming the problem of resistance-breaking biotypes.

Use of a pre-plant nematicide should be followed by a susceptible variety or a rotation crop. Then when the field has finally been cleaned up, growers should make sure to plant in cooler soil so the roots have a chance to become established enough to resist heavy nematode pressure when the soil warms up. In addition, growers should continue to rotate between resistant varieties and susceptible varieties planted after a chemical control treatment. Finally, growers should be aware that resistance-breaking nematodes can be spread between fields through the movement of equipment contaminated with nematode-infested soil. Therefore, equipment that has been used in infested fields be decontaminated by washing with water to remove soil before using in uninfested fields.

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Phytotrons – An Asset for Rapid Generation Advancement

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Rhitisha Sood[1], Vivek Singh[1]
[1]Ph. D. Scholar, Department of Genetics and Plant Breeding, CSKHPKV, Palampur, H.P.

Introduction

The growing human population and a changing environment have raised significant concern for global food security, with the current improvement rate of several important crops inadequate to meet future demand. The generation time of most plant species represents a bottleneck in applied research programs and breeding, creating the need for technologies that accelerate plant development and generation turnover. Conventional breeding is a resource-intensive activity that takes 10 years or more to develop a new cultivar. In photoperiod sensitive crops, conducting off-season nurseries can significantly reduce the length of the breeding cycle but still needs long period to release cultivars. Here, a method called 'speed breeding' introduced by NASA which greatly shortens generation time and accelerates breeding and research programmes. In speed breeding program, growing up to six generations is possible per year for wheat, barley, chickpea and four generations per year for *Brassica*. Therefore, Speed Breeding is such a tool or technique not only for rapid generation advance that significantly reduces the harvest time of crops but also helps to manage several agronomic practices such as weed management, nutrient use efficiency and biotic and abiotic stress. The development of new and improved phenotyping methods with rapid generation breeding strategies will assist breeders to develop new cultivars with improved biotic resistance. Speed breeding permit to reaching homozygosity of segregating populations breeding cycles. To accelerate speed breeding program for precision farming, several facilities have been introduced. Among them **Phytotrons** are the most common and popular facility which help in speed breeding by employing extended photoperiod and controlled temperature to accelerate growth and development of crop plants.

Phytotrons are the most complex form of controlled-environment facility to examine the impact of the environment on the plant system in order to better understand how the environment shapes it. Artificially and naturally lighted controlled-environment rooms and cabinets are used in conjunction with incubators, seed germination chambers, roomettes, photoperiod rooms and mechanically-refrigerated greenhouses to provide a multiplicity of environmental conditions. Phytotrons are distinguished from the installation with a few plant growth chambers by the fact that phytotrons are operated in such a way that a wide range of several environmental factors can be studied simultaneously. Phytotrons have an operating staff of specialists to maintain the system and the experimental material. Scientists, therefore, concentrate on research rather than maintenance and operation of equipment. Phytotrons also make efficient use of controlled environment space, since they receive steady use without periods of inactivity and the downtime due to malfunctions that often characterize plant growth chambers.

A **phytotron** is an enclosed research greenhouse used for studying interactions between plants and the environment. It was a product of the disciplines of plant physiology and botany.

Phytotron is a facility where a number of Growth Chambers and Greenhouses are organized in such a way that different environmental factors can be simulated for research studies simultaneously. They are used primarily to investigate how environment controls and modifies plant growth and development, but they are used also to complement and supplement field and greenhouse research in areas like plant breeding and introduction of new plant species and varieties.

The first phytotron was built under the direction of Frits Warmolt Went at the California Institute of Technology in 1949. It was funded by the Harry B. Earhart Foundation, and was officially known as the Earhart Plant Research Laboratory. It acquired its more distinctive nickname evidently from a joking conversation between Caltech biologists James Bonner and Sam Wildman.

The Intergovernmental Panel on Climate Change in its recent fourth assessment report predicts that, because of higher concentrations of greenhouse gases in the atmosphere, until 2100 the global mean temperature would rise between 0.6 and 4°C, in combination with changes in precipitation and an increased frequency of extreme weather events. Despite this trend, the extent and mechanisms through which elevated CO_2 affects plant diseases remain uncertain. Increase in CO_2 and temperatures are also expected to induce complex effects on plant pathogens. Although research on the effects of climate change continues to be limited, new tools are permitting to study the effects of climate variables on infection rates in the case of some pathosystems. The shortage of critical epidemiological data on individual plant diseases needs to be addressed using experimental approaches. A useful tool for such types of studies is represented by phytotrons.

Changes in agricultural productivity can be the result of direct effects of these factors at the plant level, or indirect effects at the system level, for instance, through shifts in nutrient cycling, crop–weed interactions, insect pest occurrence, and plant diseases. Despite the paramount importance of plant disease for agricultural and natural ecosystems, little is known of how plant interactions with pathogens will change under future climatic conditions.

The expression of disease symptoms is influenced by three main components: (1) host, (2) pathogen, and (3) environmental conditions. Because plant predisposition to disease is altered by abiotic factors, changes in environmental variables such as elevated CO_2 will also likely affect the severity and range of pathogens. Understanding such relationships is vital to making predictions about overall plant health and for managing agricultural and natural ecosystems in the future.

The shortage of critical epidemiological data on individual plant diseases needs to be addressed using experimental approaches. In the first instance, studies in a controlled environment may be used to formulate hypotheses and to determine critical relationships to help develop process-based approaches. Field-based research examining the influence of a combination of interacting factors would be needed to provide a more realistic appraisal of impacts. A useful tool for such a type of study is phytotron, which can be defined as a closed greenhouse that can be used for the study of environmental conditions on plant growth and for plant gas production (consumption) monitoring.

Different environmental parameters are also controlled, both atmospheric (temperature, light, humidity, etc.) and pedological (soil humidity, salinity, etc.), together with nutritional conditions. Phytotrons enable conditions to be simulated such as climatic extremes of chilling, high temperatures, photoinhibition, drought and climate change, etc.

Ion chromatography Section In the service is supplied cation analytical determinations (ammonium, sodium, potassium, calcium, magnesium), inorganic anions (nitrate, nitrite, chloride, phosphate, sulfate), organic acids (citrate, malate, glutarate, succinate, malonate, tartrate, maleate, a-ketoglutarate, fumarate, oxalate, 3-phosphoglycerate, isocitrate, phosphoenolpyruvate) and sugars (glucose, galactose, arabinose, fructose and xylose) in water and plant samples.

Phytotrons have been exploited to provide controlled and reproducible conditions for several types of studies in Plant Physiology and Phenology (Nunn 2005), Plant Biochemistry, Agronomy (Tahir 2005), Ecology (Dormann 2004), Plant Morphometry (Fukui 2004), food quality and Plant Pathology (Reignault 2001).

At present, at least in Europe, several kinds of phytotrons are already in use for studying the effect of environmental conditions and stresses on plant diseases, but in most cases, experiments were carried out in small chambers, on seedlings or small plants, without monitoring and controlling carbon dioxide concentration and not specifically designed for studying plant-pathogens interactions, in particular on foliar diseases (Pritsch 2005; Luedemann 2009).

One such phytotron facility has been raised at CSKHPKV, Palampur with different growth chambers and equipped with state of the art facilities for carrying out cutting edge research in the modern spheres of plant breeding, genetics, plant pathology, crop production management and entomology under controlled conditions to develop high yielding varieties (tolerant to biotic & abiotic stresses and efficient water &nutrient use) in the shortest possible period of time suitable to different Agro-climatic zone of the state.

Conclusion and Future Thrusts

This aims at supporting the next generation of plant scientists and student scholars to build a foundation for advanced research for developing technologies, which can be used extensively in the commercial agriculture/horticulture. This integrated facility once developed will prove boon to crop research as in such facility number of climatic variables can be simultaneously, but independently, controlled; for example, lighting (energy level, quality of light, duration of illumination), temperature and humidity etc. and will also reduce the time span for development of new crop varieties with desired parameters. Phytotron facility can be utilized for QTLs mapping, marker assisted selection and genomic selection. It can allow quick and efficient development of lines that can subsequently be stored and converted into plant to be used for phenotyping.

For the nutritional efficiency experiments in a precise manner, Phytotrons facility provides the plant growth chamber and greenhouse to study the response and effect of essential and macro & micronutrients on the growth and development of crop plants. Phytotrons have controlled-environment rooms and cabinets conjunct with incubators, seed germination chambers, roomettes, photoperiod rooms and mechanically refrigerated greenhouses to provide a multiplicity of environmental conditions.

Efficient use of fertilizers brings about an economic increase in agricultural production. However, the continuous and imbalanced use of fertilizers badly influences production potential, leaching losses, consequent reduced productivity and associated environmental problems. However, the water and nutrient saving may be further increased with scientific intervention. The infestation behavior of pests under varied environmental conditions and response of different germplasm and varieties of crops can be studied at one place and in shorter period. In fact, studies on disease cycle in correlation with environment can be done in the facility along with another research simultaneously.

Plant pathogen interactions, plant anatomy and flowering time can be studied in detail and repeated using this technology. Some weeds are problematic and reduce the yield of crops immensely. The ecology, biology, physiology of weeds and their interaction with crop plants can be studied in the space available for the purpose. The study can also be undertaken for the development of eco-friendly management techniques of different weeds. Phytotron facility for plant research for the production of new healthier crop varieties, early maturing hybrids, high-yielding varieties, is the apt answer for these research requirements.

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Chili Fruit Rot Disease and its Management

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Ravi Regar[1], Kewal Chand[2]
[1]PhD. Scholar, Department of Plant Pathology, S.K.N. College of agriculture, Jobner, Jaipur.
[2]PhD. Scholar, Department of Plant Pathology, S.K.N. College of agriculture, Jobner, Jaipur.

Introduction

Chilli (*Capsicum annuum* L.) is considered an important vegetable crop in india. India is the largest consumer and exporter of chilli in the international market and exports dry chilli, chilli powder and olioresins to over 90 countries (Singhal 1999). The major constraint to chilli production in India is fruit rot diseases, caused by Colletotrichum capsici (Syd.) Butler and Bisby and Alternaria alternata (Fr.) Keissler.

Losses varying from 10–60% have been reported in India (Patil et al. 1993; Pandey and Pandey 2003). Chili crop diseases caused by many pathogens like fungi, bacteria, virus, phytoplasma etc. among this fungal pathogen cause more infection to crop. In this chili fruit rot is important disease which caused more yield loss in chili production. To control the chili fruit, rot many management practices are apply like cultural, physical, biological management overcome the pathogen infection.

Major Fungal Diseases of Chili

Diseases	Causal organism
Damping off	*Pythium aphanidermatum*
Die-back / fruit rot	*Colletotrichum capsici*
Powdery mildew	*Leveillila taurica*
Cercospora leaf spot	*Cercospora capsici*
Alternaria leaf spot	*Alternaria solani*
Fusarium wilt	*Fusarium solani*

Chili Fruit Rot

Also known as Die-back. Causal organism – *Colletotrichum capsici*

Symptoms:

a. Disease occurs more during December – October.
b. The disease occurs in two forms:
   i. Dieback.
   ii. Ripe fruit rot.

Dieback:

a. Necrosis of tender twigs from the tip to backward.
b. Numerous black dots are found scattered all over the necrotic surface of the affected twigs.
c. Only the top or few side branches may be killed.

Ripe Fruit Rot

Figure 1: Chili fruit rot disease

1. Anthracnose symptoms appear on fruits of chili.
2. Small black circular spots are appeared on the skin of the fruit.
3. The spots are usually sunken with black margin. Badly diseased fruit turn straw colour from normal color. Sunken spots are covered with pinkish mass of fungal spores (Figure 1).
4. The fruits with many spots drop off prematurely, resulting heavy loss in yield. Seeds are also infected by this fungus.

Favourable condition

a. It requires High temperature (28 C).
b. It require High relative humidity (92% or above).

Management of chili fruit rot disease:

1. Cultural control:

a. Selection of disease-free seeds of chili.
b. Disease crop debris should be collected and burnt.
c. Early planting of chili.
d. Deep plowing.
e. Crop rotation.

2. Chemical control:

a. Seed treatment with Vitavax200 @ 2g/ kg of seed.
b. Spraying with DithaneM 45 or Bavistin @ 0.2% solution, 34 times after 15 days interval when fruit begin too ripe.
c. Application of fungicides like Mancozed (0.2%), ziram (0.1%), copper oxychloride (Blitox50) and Bordeaux mixture (0.5-1%) etc.

3. Biological control:

a. Applications of *Trichoderma* spp. effective method of control fruit rot of chili. It is the fungal antagonist.
b. Other bio-control agent like Bacillus subtilis also used for control the pathogen.

4. Plant extracts: Use of Allium sativum (10%) and Azadirachta indica (10%) are effective for control of the pathogen.

5. Use of Resistant varieties:

a. Panjab lal.
b. Bhut jolokia.

	
Figure 2: Management practice applies	**Figure 3: Without any management practice**

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Biology of Phytophagous Rice Mites in India

Article ID: 35099

Shamik Dey[1], Sitesh Chatterjee[2]
[1]School of Agricultural Science, JIS University, Agarpara, 700109, West Bengal.
[2]Rice Research Station, Chinsurah, 712102, Hooghly, West Bengal.

Abstract
Phytophagous mites are the special group of mite species which has the ability to cause several damages in agricultural and horticultural crops throughout the world. In Rice, near about thirty-one species under four families of phytophagous mite are reported among which *Steneotarsonemus spinki*, *Oligonychus oryzae*, *Caloglyphus berlesei* and *Tarsonemus cuttacki* are important in India.

Introduction
Rice ecosystem provide habitat approximately for 61 mite species among them few are phytophagous, frugivorous, predators and parasite or parasitoid on other insect or mite pests (Rao and Prakash, 1995b; 2003a). Phytophagous mites are found to cause qualitative and quantitative loss directly and also in association with different types plant pathogenic fungi and bacteria in the forms of grain sterility, ill filled grains and discoloration of the grains or seeds and necrosis in the leaf and leaf sheath tissues in the paddy fields (Cherian, 1938; Chien and Huang, 1979).

Rice Sheath Mite
Steneotarsonemus spinki Smiely.

Distribution: This mite species has been reported from India, Madagascar, Taiwan, Philippines, Japan. From India, it was reported from Odisha, Tamil Nadu and West Bengal.

Biology: The mite reproduced through facultative parthenogenesis and the virgin female laid only a few eggs, which produced only by the females (Sogawa, 1977). Chen *et al*., (1979) found its pre-oviposition period as 2-5 days and oviposition period as 2-4 days at 25°C temperature under controlled condition. Lo and Ho (1977, 1979) reported an average number of eggs laid by this mite as 59.5/female.

Paddy Leaf Mite
Oligonychus oryzae Hirst.

Distribution: This mite was very common in all rice growing area and reported from India, Malaysia, Japan and Philippines. In India, it has been reported from several states viz. Odisha, West Bengal, Tamil Nadu, Punjab, Kerala, Andhra Pradesh, Uttar Pradesh, Bihar and Haryana.

Biology: Cherian (1938) provide a comprehensive account of the early history of this mite pest in South India. Each fertilized female was capable of laying 8-21 eggs on the leaf surface in her total life cycle (Misra and Israel, 1968a). Incubation period ranged from 4-5 days during August and September but it may be extended up to 9 days in December due to fall in ambient temperature (Misra and Israel, 1968a).

The larval period lasted for 2-3 days followed by quiescent stage and ratio of the active to quiescent period was 3:2. Protonymphal period was reported from 1.5 to 2 days followed by the second quiescent stage, whereas deutonymphal period lasted for 2-3 days followed by another quiescent stage (Misra and Israel, 1968a).

Leaf and Panicle Mite
Caloglyphus berlesei Michael.

Distribution: This mite species has been reported from India, United States of America (USA), Canada and Iraq. In India, it was commonly found in Odisha, Bihar and West Bengal.

Biology: Under aseptic laboratory condition on the fungal mat of *Fusarium moniliforme* grown in 2% OMA medium, this mite was reported to complete its adult-to-adult life cycle in 10-12 days and its reproductive potential was as high as 2500-3000 mites (nymphs and adults) from the initial release of ten pairs of adults (Rao and Prakash, 1986). Rao and Prakash (1997), studied the life cycle of this mite on 2% OMA medium using *Fusarium moniliforme* as fungal diet in detail and found that its life cycle also completed through the tiny sex legged larva, protonymph, resting stage (deutonymph) and adults.

A female laid eggs 24-36 hours after its complete development to adult. Freshly laid eggs were 0.12-0.15 mm long nearly oval shaped and laid singly or in groups of 3-5. A female could lay 110-150 eggs at a time.

Fertility of the eggs was recorded from 90-95%, whereas incubation period of the eggs was observed 48-54 hours at temperature from 26-30°C. Newly hatched six-legged larva was 0.224 mm long and transparent. The active larval period was found to be 24 hours followed by another 24 hours of larval resting period.

During the resting period larva developed to protonymph in 48 hours. Protonymph was active, transparent, eight legged and measured 0.392 mm long. After 24 hours protonymph developed to deutonymph, which in fact was a resting stage, wherein it developed a round shelled structure all around and its color changed to dark brown (Rao and Prakash, 1986).

Tarsonemid Mite

Tarsonemus cuttacki Iswari

Distribution: This mite species was reported from India. In India it was discovered from Odisha, Bihar, West Bengal and Bihar.

Host: Rice plant. It attacks rice crop both in field and stored condition.

Biology: This mite could complete egg to egg life cycle through six-legged active larval and resting larval stages to adults within 7-8 days at room temperature 23-29°C on the fungal mat of *Fusarium moniliforme* grown in 2% OMA medium under aseptic laboratory conditions (Ghosh *et* al., 1993).

The egg was very small which was measured as 0.109 mm X 0.066 mm in size, transparent, oval and generally laid singly. Initially the chorion is whitish in color, which changed to light brown in color at a later stage as development progressed. Incubation period varied from 1 to 2 days with an average of 1.45 days.

Newly hatched tiny and six-legged active larva was measured as 0.189 mm long and completely transparent. The active larval period lasted for 24 hours followed by resting period of 1-2 days with an average of 1.55 days.

Newly emerged adult was light brown in color and exhibited a distinct sexual dimorphism. Adult female was brown in color, 0.242 mm in length and comparatively larger in size than the male. This mite is found to migrate from the seed to seedlings, when infested seeds are sown in the fields (Prakash and Rao, 1996).

Conclusion

Rice is attacked by different types of phytophagous mite pests and they cause significant yield loss both in field and stored condition. In order to management of this mite pest, detailed study about their biology and life cycle is required.

Henceforth, this article will be useful for taking the management decision against those mite pests if rice crop in future.

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Styles, Types and Principles of Gardening

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Swapnil Raghatate[1], Balkishor Muradi[1]
[1]Ph. D. Scholar, Department of Floriculture and Landscape Architecture, Dr. PDKV, Akola (M. S.).

Landscape garden is a design with definite use of plants to serve certain aesthetic or utilitarian purpose. It is a manmade creation for ornamental or practical or both the uses. Landscape gardening can also be defined as the arrangement of trees, shrubs, climbers and various other plants together with the building, walk, drives, artificial and natural features for the use of humanity. It is both an art and science for the establishment of a ground in such a way that it gives an effect of a natural landscape.

There are Four Basic Styles of Gardening that are Generally Followed for Establishment of Any Garden Design

1. Formal gardens.
2. Informal gardens.
3. Wild gardens.
4. Free style of gardens.

Formal Gardens

The most important and the basic feature of the formal garden is first of all the plan is made on paper and then after the land is selected accordingly. The design of the formal garden is of symmetrical and geometrical pattern. In the formal garden everything is planned in a straight and narrow way. In such garden everything is planted in straight line and in a systematic manner. In this style of gardens balance is symmetrical as same feature replicated on both sides of the central axis. For example, if there is a plant planted on the left-hand side of a straight roads a similar plant must be planted on the other side or right-hand side. The size of the beds, borders are generally square, rectangular or circular size. Roads and paths of the garden are cut at right angle. Trees and shrubs can be selected as an individual feature. Hedges, edges, topiary and trees are trimmed. Example of formal styles gardens are Mughal, Persian, Italian and French garden etc.

Informal Gardens

In an informal style of garden land is not selected according to the plan but the plan is forced to fit the land. The main aim of informal style of garden is to capture natural scenery and the whole design looks like informal. In this design plants and other features are arranged informally without following any hard and fast rule. The design of this style is generally asymmetrical, borders and flower beds are non-geometrical, hedges, edges and topiary are remains untrimmed and individual plant is not selected as a specimen plant or feature. In this style the plants are allowed to grow by their natural way without trimming and pruning. Examples of informal style gardens are English garden and Japanese garden.

Wild Gardens

Wild garden style is recent style of gardening and expounded by William Robinson in the last decade of nineteenth century. The concept of wild garden is to breaks all the rules of landscape gardening and it is against the formalism. The main idea of this style was to naturalize plants in the shrubberies. Grass should remain unmoved as in nature and few bulbous plants should be grown scattered in the grass to imitate a wild scenery. The bulbous plants should be planted among the forest flora to fulfil the idea of a wild garden. To allow the creepers to grow over the trees naturally imitating those of the forest.

Free Style Gardens

This is the new approach of gardening. In this style combines of all the good points of both the formal and informal style of gardening to create most picturesque effect. This style of gardening is suitable for any situation and condition. E. g. Rose Garden of Chandigarh is the example of free style garden.

Basic principles of gardening which are as follows:

1. Simplicity: Simplicity is the most important principle of gardening. Garden design should be simple. Simplicity can be created by planting single species. Avoid too many species, colors, textures shapes in the garden which creates confusion. Avoid to use of too many features in the garden.

2. Unity: Unity means that all the parts of landscape design go together. Unity can be achieved by using mass planting and repetition. Unity can be achieved by various angles or ways. Firstly, the unity of style, feeling and functions between the house and garden has to be achieved. Secondly the different components of garden design should merge harmoniously with each other. In this way the unity can be achieved in the garden.

3. Harmony: It is an overall effect of various features, styles and colour schemes of the total scene. When the different features and parts of the landscape are placed correctly in proper and right way then harmonious effect produces.

4. Balance: It is very important to maintain the balance on both side of the central line. See saw game can help to understand the principle of balance. It refers to the equilibrium or equality of usual attraction. It is used to maintain optimum symmetry in garden. One side planted with trees will not make balance if other side is planted with shrubs or climbers. Similarly, one side planted with tall upright trees will not make balance with other side if planted with dwarf or weeping trees. Main balance with colour is difficult until and unless used properly. Red, yellow and orange are grouped in to heavy and orange are grouped in contrast, white, green and blue are light and cool colours. Deeper shade is heavier than its lighter counterpart. Proper balance by selecting appropriate colours should be done to create the desired effect. Texture of leaves may be rough, coarse, fine or smooth. So proper balance is achieved between different types of texture.

5. Proportion or Scale: It is the relation of one thing to another in magnitude. When two or more objects are put together the proportions are established. In a landscape design, space for lawn, paths, herbaceous borders, shrubbery borders, trees, buildings and other garden objects should be in right proportion. It will create harmonious effect and look better.

The space for the different features should be in right proportion.

a. Lawn (25-30%)
b. Paths (20%)
c. Herbaceous border (20%)
d. Shrubbery (15-20%)
e. Trees (15%)
f. Building (25-30%)

6. Focal point or Accent or Emphasis: The feature which attracts the eye is known as accent or focal point or emphasis. The accent or focal point or emphasis is created in the gardens to avoid the monotonous view. The feature attracts the viewers' attention through its forms, habit, colour, size, sound and motion. Landscape designer should know what to emphasize, where to emphasize and how much to emphasize. Mostly unusual objects like tall fountains, trees, and statues etc. are used to create the effect of accent or focal point. In English garden generally statues are used to create such effects.

7. Rhythm: Repetition of same object at equidistant is called as rhythm. Rhythm is an easy connected path along which the eye will travel in any direction from one point to another without disturbance. Rhythm in a design can be created by using three ways, through repetition of shapes, progression of sizes and continuous line movement.

8. Mass effect: Mass effect in a garden can be created by using one general form of plant material in large numbers at a one place. The size of the masses should be varied.

Major Diseases of Rose and their Control Measures

Article ID: 35101

Swapnil Raghatate[1], Balkishor Muradi[1]
[1]Ph. D. Scholar, Department of Floriculture and Landscape Architecture, Dr. PDKV, Akola (M. S.).

Die Back

This is a serious disease of rose caused by the fungus *Diplodia rosarum* Fr. but in the recent years, other several fungi have been observed in the diseased twigs like *Botrydiplodia theobromae, Colletotrichum gleosporoides, Fusarium sp.* and *Phomopsis sp*. The disease caused from top of the plant to downwards. The disease normally starts from the pruned surface of the twigs and initially observed few centimeters below the pruned end and in severe cases disease spread in the other part of the plant and entire plant kills.

Control Measures: Soil drenching with 2 g/l bavistin, benomyl or demosan and spraying captan or mancozeb 0.2% or copper oxychloride immediately after pruning and then twice at 10 days interval found effective to control die back disease of rose. The incidence of die back of rose can be reduced by planting tolerant varieties like Abhisarika, Arjun, Bhim, first prize, Priyadarshini, Montezuma and Mercedes these are some hybrid tea varieties. Floribunda varieties tolerant to die back are Arunima, Delhi Princess, Fantasia, Gabriella, Folklore, Jantar Mantar, Lahar, Madhura, Neelambari, Sadabahar and Suchitra.

Black Spot

Black spot disease of rose is caused by fungus *Diplocarpon rosae* and this disease is also called as leaf spot, leaf blotch, blotch and star sooty mold. Black spots of size 2-12 mm diameter appear on upper leaf surfaces. These black leaf spots are circular or irregular in size with characteristic feathery, radiate, fibrillose margins of sub cuticular mycelial strands. The tissues of leaf surroundings the spots turn yellow and chlorosis extends in the whole leaflet until abscission occurs.

Control Measures: The rootstocks like IARI Thornless and IIHR Thornless are found tolerant to this disease and incidence of this disease can be reduced by using tolerant rootstocks. The infected leaves should be clipped off and removed by burning. Spray of benlate (0.1%) or bavistin (0.1%) found most effective to control the black spot disease of rose.

Powdery Mildew

It is also a major disease of rose and found all over the world. Powdery mildew of rose is caused by the fungus *Sphaerotheca pannosa var. rosae*. This disease affects all the aerial parts of the rose plant and the leaves affected more. Younger leaves of the plant get curled and leaves are appearing purplish than the normal leaves. In the leaves raised blister like areas develops and coated with white powdery growth of fungus. Highly infected flower buds are failing to open. Petals are discoloured, dwarf and completely die. Incidence of this disease occurs during November-March and its maximum intensity till January-February. In greenhouses powdery mildew disease occurs when the temperature range is optimal or lower and the humidity is high during night and low during the day.

Control Measures: Some protective fungicidal sprays are found beneficial to control this disease at repeated seven-day schedule. Also, this disease can be control by lowering the night humidity by using fans and venting or by heating. *Rosa multiflora* is resistant to powdery mildew disease of rose. Varieties which are resistant to powdery mildew are Gladiator, Raktagandha, First Prize, Avon, Montezuma and Eiffel Tower etc.

Botrytis Blight

This disease is caused by the fungus *Botrytis cinerea*. This disease occurs during rainy season which results in severe blighting of buds and twigs. Brownish patches appear on the petals of affected buds which soon engulfs the entire surface and cause rotting. Below the twigs discoloration extends which wholly or partially killing the twigs. Whitish grey frutification develops over the surface of blighted portion under foggy and high humid condition. The infection of this disease is generally observed in the inner whorl of the flowers.

Control measure: Spray of fungicides like bavistin (0.2%), benomyl (0.2%) or rovral (0.2%) at regular intervals found beneficial to control this disease. The disease develops fast on the wounded or injured tissue and senescent tissue. The infected parts of the plant and infected flowers should be removed from the field. High moisture and overwatering on leaves or flowers should be avoided.

Rust

Rust in rose is caused by the fungus *Phragmidium mucronatum*. The main symptoms of this disease is chlorotic spots on the leaf surface. The orange coloured uredial spores are commonly observed and results of infection of this disease is defoliation of leaves.

Control measures: Spray of some chemical like Saprol (0.2%) or bayleton (0.15%) are found effective to control the infection of this disease.

Crown Gall

This is a bacterial disease of rose and caused by the bacteria *Agrobacterium tumefaciens*. At the crown region of the stem at the ground level cauliflower like galls are produced. Galls also produced on the roots, on wounded stems during harvesting, pruning and other cultural operations. This disease affects the propagation of plant.

Control measures: This disease can be control by following clean nursery practices, using of disease-free planting material and removal of infected plant parts and debris. Commercial formulations consisting *Agrobacterium tumefaciens* (K-84) is used successfully to control crown gall in rose in many countries.

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Immunity Boosting Foods & Role of Nutrients in Enhancing Immunity

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Ch. Anusha[1], Dr. T. Kamalaja[2]
[1]PGRC, Department of Foods and Nutrition, PJTSAU, Senior Scientist, AICRP-H. Sc, Department of Foods and Nutrition, PGRC, PJTSAU.

Introduction

On the daily basis, we are constantly exposed to potentially harmful microbes of all sorts. Our immune system protects us against the harmful microbes as well as certain diseases. It recognizes foreign invaders like bacteria, viruses and parasites and takes immediate action. Human beings possess two types of immunity: Innate immunity and Adaptive immunity.

Innate immunity: Innate immunity is achieved through the protective barriers and acts as a first line defence from pathogens. Barriers includes skin, mucus, stomach acids, enzymes in sweat and tears etc.

Acquired or Adaptive immunity: Immunity acquired by infection or vaccination or by the transfer of antibodies or lymphocytes.

Foods and Nutrients in Improving Immunity

Eating enough nutrients in our daily diet is required for health and functioning of all the cell, including immune cells. Nutrients like vitamin C, vitamin D, Zinc, Selenium, Iron, protein (amino acids like Glutamine) have been identified as the critical for the growth and function of immune cells. A deficiency of the single nutrient can alter the body`s immune system. Deficiency in Zinc, selenium, iron, copper, folic acid and vitamins like A, B6, C, D and E can alter immune response. These nutrients help the immune system in working as an antioxidant, supporting growth and activity of the immune cells and in producing antibodies. Feeding our body with certain foods may help in keeping our immune system strong.

Citrus Fruits:

a. Vitamin C thought to increase the production of white blood cells which fights infections.
b. Some of the research shows that vitamin C reduce the severity and duration of the symptoms associated with cold and flu.
c. Vit C also involved in making the collagen necessary for maintaining healthy skin which is front line defender against viruses.
d. Almost all citrus fruits are high in vitamin C. The most consumed citrus fruits are: orange, lemon, lime, grape fruit, strawberries.

Broccoli, kale & spinach:

a. Broccoli is packed with vitamins A, C, E as well as fiber and many antioxidants.
b. Kale contains high level of vitamin C, important for immune function. It also contains high mount of beta carotene which will be converted into vitamin A and helps in boosting the immunity.

Oats: Whole grain oats contain high amount of beta glucan; a compound shows to activate immune cells that fights infectious organisms. These are also richest source of Zinc which is a source for immunity building.

Beans: All beans are good source of soluble fibre and also contains antioxidants and folate, a B vitamin which is required for the production of new immune cells.

Black Rice: Recently research shows that black rice also known as forbidden rice contains high level of antioxidants which protects immune cells from oxidative damage.

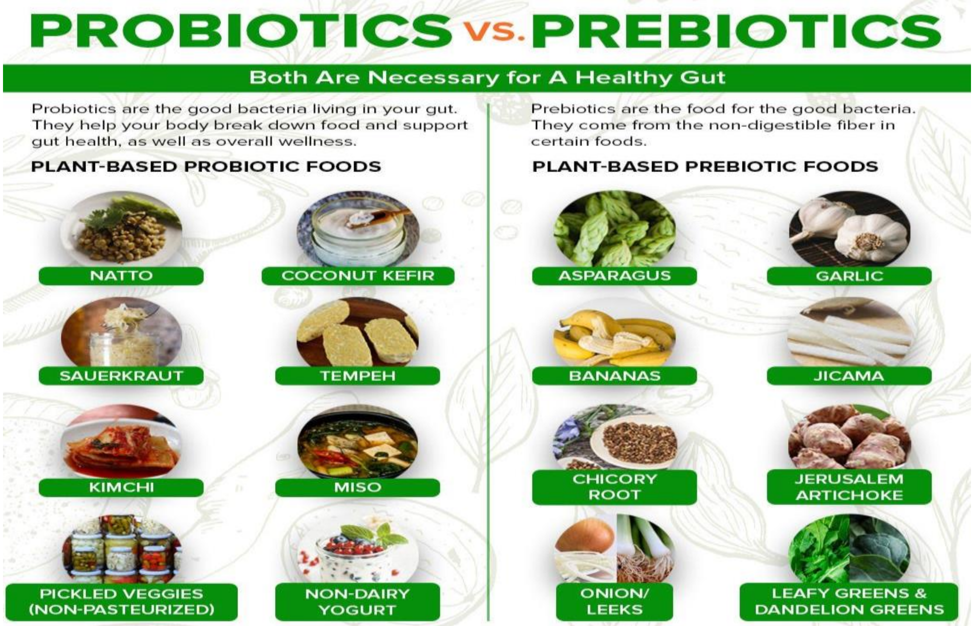
Pumpkin seeds: Pumpkin seeds are rich in zinc which plays a central role in immune functioning by increasing the production of immune cells.

Sunflower seeds: Sunflower seeds contains high amounts of vitamin E which is important in regulating and maintain of the immune system, B6 and also packed with selenium, phosphorous, magnesium.

Papaya & kiwi: Papaya and kiwi are loaded with tons of essential nutrients; vitamin C content is present in higher amounts helps in boosting the white blood cells to fight against infections. They also contain folate, vitamin K, potassium helps in body functioning.

Probiotic food: includes yogurt, fermented vegetables, tempeh, miso etc.

Prebiotic food: includes garlic, onions, asparagus, bananas, seaweeds etc.



Role of Nutrients in Enhancing Immunity

Role of Vitamin C:

a. Vit C founds mainly found in white blood cells
b. It supports cellular immune response.
c. Enhances the function of phagocytosis, and nitrogen oxide production.
d. Enhances the production of B and T lymphocytes.
e. Supports the activity of natural killer cells.
f. Neutralizes the oxidative stress.
g. Make bacterial membrane more permeable to some antibiotics.

Role of vitamin E:

a. Vitamin E is one of the most effective nutrients known to modulate immune function.
b. Vitamin E has a protective effect against oxidation of poly unsaturated fatty acids which are enriched in membrane of immune cells.

Role of vitamin A:

a. Vitamin A is a micro nutrient that is crucial for maintaining vision, promoting growth and development.
b. Vit A is known as an anti-inflammatory vitamin because of its critical role in enhancing immune function.
c. Vit A has both promoting and regulating roles in both innate immune system and adaptive immunity so it can enhance the organism`s immune function and provide defense against infections.

Role of vit- B6:

a. Helps regulate inflammation.
b. Has roles in cytokine production and NK cell activity.
c. Required in the endogenous synthesis and metabolism of amino acids, the building blocks of cytokines and antibodies.

Role of Vit – B12:

a. Has roles in NK cell functions.

b. May act as an immunomodulator for cellular immunity, especially with effects on cytotoxic cells (NK cells, $CD8^+$ T-cells).
c. Facilitates production of T lymphocytes.

Role of vit D:
a. Vitamin D receptor expressed in innate immune cells (e.g., monocytes, macrophages, dendritic cells)
b. Stimulates immune cell proliferation and cytokine production and helps protect against infection caused by pathogens.
c. 1,25-dihydroxyvitamin D_3, the active form of vitamin D, regulates the antimicrobial proteins, which can directly kill pathogens, especially bacteria.

Role of copper:
a. Has roles in antibody production and cellular immunity.
b. Has roles in T cell proliferation.
c. May play a role in the innate immune response to bacterial infections.

Role of Iron:
a. Involved in regulation of cytokine production and action.
b. Forms highly-toxic hydroxyl radicals, thus involved in the process of killing bacteria by neutrophils.
c. Essential for cell differentiation and growth, component of enzymes critical for functioning of immune cells.

Role of Folate:
a. Maintains innate immunity (NK cells).
b. Has roles in cell-mediated immunity.

Role of Zinc:
a. Helps maintain skin and mucosal membrane integrity.
b. Central role in cellular growth and differentiation of immune cells that have a rapid differentiation and turnover.
c. Essential for intracellular binding of tyrosine kinase to T cell receptors, required for T lymphocyte development and activation.

Role of Selenium:
a. Selenoproteins are important for the antioxidant host defense system affecting leukocyte and NK cell function.
b. Involved in T lymphocyte proliferation.
c. Has roles in the humoral system (e.g., immunoglobulin production).

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KVK: "KRISHIMANDIR" for the Farmers of the District

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Naik Nidhi K.[1], Pandya C. D.[2]

[1]Naik Nidhi K., M.Sc. (Agri.), Department of Extension Education, N. M. College of Agriculture, Navsari Agricultural University, Navsari.

[2]Pandya C. D., Senior Scientist and Head, Krishi Vigyan Kendra, Navsari Agricultural University, Vyara, District: Tapi.

Summary

Krishi Vigyan Kendra (KVK) is transferring technology through trainings, Front Line Demonstrations, On Farm Trials and various extension activities for the holistic development of farmers of the district. Farmers can find their solution about agricultural and allied sector at KVK. Krishi Vigyan Kendra is serving to the farmers in all aspects. So, we can say that KVK is "KRISHIMANDIR" for the farmers of the district.

Introduction

There are four main transfer of technology projects of the ICAR, namely the All India Coordinated Project on National Demonstrations (AICPND), Operational Research Project (ORP), Krishi Vigyan Kendra (KVK) and Lab to Land Project (LLP). As per the recommendations of Mohan Singh Mehta Committee during 1974, KVKs were established in different states. Krishi Vigyan Kendra (KVK) is a noble concept developed by Indian Council of Agricultural Research (ICAR) which was rest upon a solid base of transfer of technology from laboratory to farmer's field with respect to Agriculture, Horticulture, Animal Husbandry, Floriculture, Bee keeping, Mushroom Cultivation, Broiler Farming and allied subjects. The first KVK was established in 1974 at Pondicherry under the administrative control of the Tamil Nadu Agricultural University, Coimbatore. At present 721 KVKs including 30 KVKs of Gujarat are established and functioning in the country.

Case Study

KVK of Tapi district showed that recommended installation of pheromone traps @ 60 traps per hectare noted highest production of okra (116.4 quintal per hectare) with higher net return (₹ 244400.00) and highest Benefit Cost Ratio (1:3.33) as compared to farmer's practices of injudicious and indiscriminate use of chemical pesticides. So, recommended practice by KVK found best technology to be adopted by farmers for effective management of shoot and fruit borer in okra as reported by Anonymous (2019). The yield of mustard before Front Line Demonstration was 18.35 quintal per hectare while after Front Line Demonstration, the yield was 23.56 quintal per hectare. The prevailing market price was ₹ 2190.00 per quintal and on that base profitability was calculated which showed that net profit from mustard crop before Front Line Demonstration was ₹ 28289.00 per hectare while the net profit from mustard crop after Front Line Demonstration was ₹ 37961 per hectare. The Benefit Cost Ratio for before Front-Line Demonstration was 1.00 while after Front Line Demonstration was 3.78 as reported by Patel and Patel (2014). The low, medium and high level of knowledge before intervention by KVK was 45.40, 32.70, 21.90 per cent, respectively which changed to 14.50, 49.10 and 36.40 per cent after intervention of KVK through training and Front-Line Demonstrations as reported by Behera *et al.* (2018). The majority (90.00 per cent) of trainees had medium to high level of attitude towards KVK training programme as reported by Patel *et al.* (2017). The advisory through message was needful and timely for 80.00 per cent of Kisan Mobile Advisory received by farmers and 72.00 and 66.66 per cent for extension personnel and input dealers. Less numbers of farmers (08.80 per cent), extension personnel (24.00 per cent) and input dealers (20.00 per cent) reported the messages were needful and not timely for them while only 02.22 per cent farmers reported that advisory was not needful and not timely as reported by Hadiya (2019).

Conclusion

1. On farm trials conducted by KVK were assessed and refined the technology in farmer's condition.

2. Front Line Demonstrations are boon for the farmers of the district as after it's conduction by KVKs, knowledge of the farmers has improved along with higher Benefit Cost Ratio of the crops.
3. Training provided by KVKs improves the knowledge of farmers about scientific methods and improve the attitude towards vocational training. So, it can be said that training provided by KVKs are timely supplement for the farmers of the district to adopt improved technologies and knowledge.
4. Farmers of adopted villages are more aware about new technologies and farmers having favourable attitude towards KVK activities. So, it can be said that different extension activities conducted by KVK plays a vital role in transfer of technology among farmers of the district. So, the "KVKs are the KRISHIMANDIR for the farmers of the district".

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Seed Treatment with Biochar: A Promising Agricultural Intervention

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Rupa Das[1], Saikat Biswas[2]
[1]Department of Seed Science and Technology,
[2]Department of Agronomy,
Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India-741252.

Introduction

Improvement in crop productivity relies on many factors. Two such factors are ideal crop seed germination and vigorous early plant stand. High seed germination coupled with robust seedling growth enhances the crop productivity to a high extent. Nutrient and water stresses are the two major constraints that affect the seed germination and early seedling growth. In order to check such constraints, among many alternatives, seed treatment is gaining attention. In this regard, choice of seed treatment materials plays crucial role to the success of seed treatment. There have been many seed treatment materials (organic or inorganic in nature) available and tested in many crops. One recent intervention is to try biochar as seed treatment material.

What is Biochar?

Biochar is a carbon enriched material prepared from controlled pyrolysis of the organic wastes through heating at high temperature (>250ºC) under no or limited O_2 supply. Organic wastes include wood, manure, leaves, straw/stubbles, dry weeds, sawdust etc.

Biochar mainly contains high amount of stable organic carbon, ash as well as various macro and micronutrients. However, biochar often contains some volatile organic compounds or harmful substances such as crystalline silica, dioxin, polyaromatic hydrocarbons, phenolic compounds and heavy metals etc. which possess threats to plant, animal and microorganisms (Solaiman *et al.*, 2012). Quality of biochar depends on heating temperature (chemical properties and pore size of biochar) and organic wastes used (carbon and other nutrients of biochar).

Benefits of Biochar

1. Biochar can increase pH, CEC, nutrient availability and water holding capacity of the soil.
2. It decreases bulk density; increases soil aeration, structure and porosity, and reclaims degraded soil.
3. It also improves soil biological properties. It is highly porous in nature and thus, provides habitat to microorganisms by protecting them from predation and desiccation.
4. Biochar can mitigate impacts of climate change by sequestering high amount of carbon as stable form in the soil.
5. It is recalcitrant to decomposition. Therefore, it persists in soil for a long time and provides nutrition to crops season after season without the need of supply in every season.
6. Biochar can increase seed germination and early seedling growth.
7. It plays an important role as highly effective adsorbent to remove harmful heavy metals and phytotoxic compounds. It adsorbs herbicides, pesticides or neutralize organic materials from soil (Jones *et al.*, 2011).
8. It reduces/recycles organic wastes.

Seed Treatment

Seed treatment refers to application of materials (organic or inorganic in nature) to seeds with the objective to improve germination and plant stand as well as to protect the plant from insect pests and diseases.

Advantages of Seed Treatment

1. It alleviates water and nutritional stresses.
2. It provides nutrition to the seeds.

3. It acts as medium for beneficial microbial inoculations.
4. Seed treatment can be done with pesticides for controlling insect pests and diseases.
5. It improves seed germination and root growth at early stage by supplying nutrition and conserving water.

Seed Treatment with Biochar

Apart from soil and foliar applications, in recent times, researchers are trying for alternative use of biochar as seed treatment options. Most of their outcomes hold good prospects of this promising agricultural intervention. James (2015) observed that seed coating with groundnut husk biochar improved seed germination and growth of California brome and blue wild rye. Camara-Williams (2019) studied the impact of seed pelleting with biochar on soybean and observed that seed pelleting with groundnut husk biochar increased number of branches at flowering, number of leaves, leaf area, nodule numbers, nodule fresh and dry weights, crop growth rate, leaf area index, relative growth rate, dry matter and yield of soybean, followed by rice husk biochar.

Thomas (2021) reported improvement in seedling development of temperate tree species through seed treatment with biochar. Olszyk *et al*. (2018) noticed little effect of seed treatment with biochar on seed germination and improvement of shoot dry weight of carrot, cucumber, lettuce, oat and tomato. Biochar consists of various macro and micro nutrients which through seed treatment can provide nutrition to the seeds for germination and subsequent seedling growth. Further, seed coating with biochar retains water around the seeds and thereby, creates favourable condition for seedling development. Biochar, apart from its sole use as mitigation strategy of nutrient and water stresses, can be a good carrier of bacterial inoculants too and thus, stimulates the plant growth through combined benefits of biochar and beneficial bacteria. Glodowska *et al*. (2017) observed that biochar-based seed coating with *Bradyrhizobium japonicum* maintained bacterial population up to 37 weeks and thus, improved effective nodulation of soybean and biological nitrogen fixation. In another study, Glodowska *et al*. (2016) found improvement in seed germination and seedling growth of corn through seed treatment with *Pseudomonas libanensis* inoculated hard wood biochar. It is noted that bacterial survival and activity depends on waste raw materials, pyrolysis temperature, degree of oxidation, pH and other physico-chemical properties of biochar. During seed coating with biochar, binder (to adhere biochar to seeds), filler (peat, talc, vermiculite clay, calcium carbonate, limestone etc.) and active ingredient are added in to it. Binder (guar gum, starch, lignin etc.) plays important role in biochar seed treatment/coating. Chen (2021) observed that biobased binder and starch binder played important roles in seed germination and root growth of radish, lettuce, coreopsis and white birch.

Consideration Prior to Seed Treatment with Biochar

Some biochar contains phytotoxic or volatile organic compounds which may harm the germination of seeds (Williams *et al*., 2016). Therefore, care should be taken prior to use of biochar through phytotoxicity test. Efficacy of seed treatment with biochar depends on type of seeds, biochar types and properties and agro-climatic conditions. Hence, selection of most suitable biochar for seed treatment should be done considering the types of seeds, composition or type of raw material used for biochar preparation, method of biochar preparation along with agro-climatic condition.

Conclusion

Biochar application in agriculture is not new. Since ancient times, charcoal application is somewhat improving the crop productivity. It also helps in mitigating agricultural wastes which otherwise, contaminate air, water and soil. Keeping in the mind that biochar is of organic origin and its use in agriculture is safe for the environment, researchers are exploring this beneficial component in different way for application in agriculture to achieve crop productivity on a sustainable manner. So far, lots of works have been carried out showing the benefits of biochar when applied to the soil. However, use of biochar as seed treatment options was very less explored. Thus, it opens a new door for the researchers with ample scopes of further elucidation through research works. Multi-locational, multi-crop and multi-varietal research trials with different types of biochar should be done repeatedly on a long-term basis for robust interpretation and recommendation of this new promising agricultural intervention to the farming community.

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Duck Farming: A Profitable Source of Income to the Farmers in Trible Areas

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Pratima Ningaraddi Morab[1], Roopa K. Muttappanavar[2]
[1]M. Sc (Agri) Department of Agronomy, UAS, GKVK, Bangalore, Karnataka-560065.
[2]Ph.D. Research Scholar, Department of Agronomy, UAS, GKVK, Bangalore, Karnataka-560065.

Introduction

Duck farming plays a pivotal part within the agricultural economy in Asian continent which solely accounts for 82.6% of the entire duck meat production of world. The duck meat and eggs are favored and consumed by people worldwide.

Indigenous ducks of our country constitute more than 90% of the total duck population and the second largest species after chicken which contributing towards egg and meat production in India. In India rearing of ducks is still in the hands of poor rural farmers, who depend mainly on ducks for their livelihood and employment, they rear duck on natural scavenging system in backyard. Among various species of poultry, ducks are sturdy, prolific and disease resistance in nature.

Duck farming and rising is a remunerative livestock industry in the globe because of its egg, meat and feather production. Poultry meat and eggs are one of the most widely consumed animal origin proteinaceous food in various parts of the world, across a wide variety of cultures, traditions and religions.

1. Ducks make a significant contribution in providing high-quality nutritional food needs, duck eggs contain all essential amino acids required by the human diet and are a good source of vitamins and minerals.
2. Due to lower water content duck eggs have more nutrient than chicken eggs.
3. Due to high nutritional value with complete essential amino acid composition and good fatty acid, people consume the duck meat, however; the production of meat and duck eggs is still lower than chickens.
4. Ducks make a significant contribution in providing high-quality nutritional food needs however; the production of meat and duck eggs is still lower than chickens.

As compare to chicken ducks are more prolific and more adaptable to free-range system of rearing. They also grow faster than chicken. That is why; they are more popular in many European and Asian countries.

Systems of Duck Rearing

Free range system: The ducks are kept in enclose only at night. At during the day time, the ducks are free to roam outside for search of feed. And brought inside at night by putting some feed in extra amount in the shelter. The ducks only require night shelter and nests for laying eggs. Ducks will stay around the place, provided you treat them well. Advantage of this system is that the ducks go to the feed and harvest it themselves. This way, nutrients become available that the farmer cannot reach otherwise. Some farmers in herd their flocks to graze large areas after the rice harvest.

Confined system: Ducks are kept enclosed permanently, either in a covered shelter (indoor system / intensive system) or with a run in the open. The ducks stay in the same place. It is easy to keep an eye on them and check them. An outside run of duck makes it easier to give the access to water, when pond can be put in the open run area.

Indoor system: The indoor system is for large-scale duck farms and where the production is mechanized to reduce labour costs. The system requires more investment than the other two systems of housing. Farmer responsibility that, has to provide all feed and water properly and clean shelter regularly. If properly managed, growth can be fast and production cheap. In indoor system provide a large shallow container with water so that ducks can wash and bath. Like open drinkers they should be located over a drained area covered with wire or slatted floor.

Integrated Duck Rearing Systems

Duck-cum-rice system: In paddy fields ducks eat harmful snails and insects, this is helps to the paddy crop and at the same time the ducks get nutritious feed so there will be a mutual benefit to each other.

Duck-cum-fish system: Waste from the duck shed can be recycled and may be used for fish culture in integrated duck-fish farming. This process increases the production of natural food in.

Duck, fish with paddy cultivation: Duck and fish can be reared together in the same field where paddy is being cultivated. The duck manure can also be used as a source of organic matter in fish farming to improve the growth of both phytoplankton and zooplankton which serves food source for fish. Droppings from duck can encourage the growth of aquatic snails, worms and other aquatic fauna and flora that act as feed for ducks.

Feed Stuffs for Ducks

Feed is one of the most important factors to consider in any farming venture. Feed alone constituent about 70% of total production cost.

Duckling

Most of the farmers provided broken rice, crushed snails and cooked rice to the ducklings up to 15 days of age. After that they were fed kitchen waste, paddy grains, cooked arum (root), cooked vegetables and cooked rice, in addition to the feed received from foraging. The duck farmers in Tamil Nadu fed their ducklings different diets according to age.

Adult Duck

The primary sources of feeding for adult ducks were post-harvested paddy fields for grains, ponds and waterlogged areas for fish, snails and insects. The survey also found that ducks in some areas were driven to distant locations in search of water for grazing and watering during periods of drought. Under the traditional systems of duck production, ducks can scavenge on their own to obtain the necessary nutrients needed for their growth. By this feed supplementation (manufactured) can be avoided and subsequently reduction in feed cost. Non-conventional feedstuffs have been demonstrated to be valuable feed for poultry. Feed supplementation increased egg production of indigenous ducks. Increasing ducks" production under semi-scavenging system is closely related with the development of feeding system.

Management of Duck

Duckling: Electric lamps were used as a heat source for the first 1-2 weeks for brooding of ducklings. Ducklings up to 15 days of age were confined in enclosures in open areas surrounded by bamboo baskets specially made for this purpose. From 7 days of age, they were allowed to swim in nearby ponds, waterlogged areas or canals. At night, ducklings were housed in one corner of the farmer's dwelling house, enclosed by wooden or bamboo mats.

Adult Ducks: The farmers usually kept adult ducks under a scavenging or free-range rearing system in which the ducks were let loose in the morning and returned to the farmer's home yard in the evening. During the night they were put in a holding pen constructed on an elevated area surrounded by paddy fields.

Health Management

The most prevalent diseases were duck plague, duck cholera, hepatitis and botulism. Diseases in ducks, is most likely the result of unsanitary surrounding and faulty management or inherent weakness due to breeding. Ducks are more vigorous and less subject to diseases than chicken and turkeys. The highest mortality in local ducks due to duck cholera. Mortality due to diseases was 10-15% in ducklings and below 10% in adults. The health protection offered by the farmers included occasional vaccination against duck plague, treatment with common antibiotics, potash solution, local vodka and black pepper. Flocks were routinely vaccinated against duck plague.

Prevention and Control

1. Different types of anathematic drugs should use for controlling parasitic control.
2. Vaccinations - Some diseases are so infectious or so common in ducks by vaccinating the ducks, can protect them. Good hygiene and vaccinating ducks are the two most important aspects of preventing ducks becoming ill.
3. Purchasing disease free stock, sanitation, mineral & vitamin supplementation, periodic used of coccidiostat, deworming and following schedule vaccination are the important steps for prevention of diseases.

Conclusion

1. Duck keeping was a subsidiary source of income in India. Duck farming in India is in an emerging sector.
2. Ducks have long productive and profitable life i.e., they lay eggs profitably during second and third year also.
3. Ducks supplement their feed by foraging; hence it will reduce the feed cost.
4. Duck farming is having symbiotic relationship with paddy cultivation, so ducks and paddy cultivation can be integrated in the entire paddy farming areas.

5. The knowledge of traditional duck production is required to established in India because improper management practices lead to lowers the production.
6. These are quite intelligent birds and they can be easily trained for their daily routine, and it reduces the labour for management.

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Plasma Water: It's Role in Agriculture

Article ID: 35106

Roopa K. Muttappanavar[1], Pratima Ningaraddi Morab[2]
[1]Ph.D. Research Scholar, Department of Agronomy, UAS, GKVK, Bangalore, Karnataka-560065.
[2]M. Sc. (Agri.) Department of Agronomy, UAS, GKVK, Bangalore, Karnataka – 560065.

Introduction

Plasma is referred as the fourth state of matter comprised of positive and negative ions, electrons, excited and neutral atoms, free radicals, molecules in the ground and excited states and the UV photons. Plasma can be produced in the laboratory by heating a gas to an extremely high temperature, which causes vigorous collision in between atoms and molecules so that electrons are ripped free, yielding the requisite electrons.

Plasma treatment of water is called as plasma activated water (PAW). It creates an acidic environment which results in changes in the redox potential**,** conductivity and in the formation of reactive oxygen species (ROS) and reactive nitrogen species (RNS).

Recently, cold atmospheric **plasma technology** has received more attention in agriculture in general and in food processing in particular. Plasma can also be used in agricultural field to enhance seed germination, plant growth, plant protection against pests and diseases and as an anti-microbial agent.

Why Plasma Water in Agriculture?

1. PAW appears to have a synergistic effect on the disinfection of food while it can also promote seedling growth of seeds.

2. The increase in the nitrate and nitrite ions in the PAW could be the main reason for the increase in plant growth.

3. Soaking seeds in PAW not only serves as an anti-bacterial but also enhances the seed germination and plant growth.

4. PAW could potentially be used to increase crop yield and to fight against the drought stress environmental conditions.

How Plasma Water can be Produced?

Plasma water is also known as Plasma Activated Water (PAW) is produced by making use of:

a. Ambient air is brought into the plasma phase with electrical energy and plasma activated air is brought into contact with water.
b. Reactive oxygen and nitrogen are dissolved into the water creating Plasma Activated Water.

1. Plasma generation in sea water through thunderstorm: Naturally, when thunderstorm comes in contact with sea water there is a generation of plasma which is responsible for generation of plasma activated water.

2. Artificial generation of plasma activated water: Based on the natural phenomena artificial Plasma activated water is generated using air, water and electricity.

There are Two Major Approaches of Generating Plasma Water

1. Plasma in contact with liquids.
2. Plasma directly in water.

A gas discharge (plasma) is initiated via a plasma power supply in an oxygen and nitrogen containing gas flow. This ionizes the gas flow, creating ions, radicals and reactive species:

a. The species are formed in the liquid or at the liquid–gas interface.
b. The type and the concentration of the reactive species that are present in PAW depend on the gases and liquids used to generate plasma.
c. Depending on the chemical environment, excited voltage and generation mode, reactive oxygen species (ROS) and reactive species (collectively described as RONS) may be formed.

d. The treatment time and gases used, the distance between the liquids and plasma plume, nature of electrodes are also important issues.

Uses of Plasma in Agriculture

1. Sterilize seeds while in storage.
2. Enhance seed germination.
3. Air cleaning, sterilization, and removal of volatile organic compounds in greenhouse facilities.
4. Treatment, sterilization, and cleaning of water used for produce washing after harvest.
5. Disinfection of produce before packaging.
6. Air cleaning, sterilization, and removal of volatile organic compounds in the packaged produce storage facility and transportation vehicles.
7. Control of pests and pathogens at the in-store display case and in-store storage.
8. Sterilization of cutting boards, knives, and other food processing equipment both at home and in food processing facilities or grocery stores.
9. Plasma-assisted destruction of hazardous waste and/or waste-to-energy conversion of the non-hazardous food wastes.

Even though plasma having many advantages in agriculture we cannot use the gas plasma due to some disadvantages but, we can overcome these disadvantages by using the plasma activated liquid (plasma water).

Role of Plasma Water in Agriculture

Plasma Water has been shown to:
1. Increase rooting speed
2. Reduce water consumption
3. Enhance seed germination
4. Stimulate plant growth
5. Prevent pests and diseases
6. Increases the nitrogen content of the water.
7. Ability to control pH.
8. It is used to sterilize crops after the harvest.

Plasma Products

Plasma Growth Accelerators are as follows:
1. The Plasma Growth Accelerator is the flagship product of PlasGro
2. Nature's Plant Supplement
3. 100 % chemical free!

Conclusion

1. Plasma can be used to change the physiochemical properties of water which is favourable for agriculture application
2. Plasma activation contribute to increase the germination rate, root elongation and plant growth
3. Treatment with plasma water for 30 minutes is found to be effect in crop protection and microbial inactivation.

Future Prospects

Combined use of plasm water with fertilizers or growth regulators and its feasibility for commercial application in field / horticultural crops is needed.

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Remote Sensing: A Revolutionary Approach in Pest Management

Article ID: 35107

Roopa K. Muttappanavar[1], Pratima Ningaraddi Morab[2]
[1]Ph.D. Research Scholar, Department of Agronomy, UAS, GKVK, Bangalore, Karnataka-560065.
[2]M. Sc. (Agri.) Department of Agronomy, UAS, GKVK, Bangalore, Karnataka – 560065.

Introduction

The push for increasing productivity and the increased pressures imposed by plant pests have an impact on modern agriculture. Geographic Information System (GlS) and Remote Sensing (RS) information are now being employed in Precision Agriculture applications for variable rate application (VRA) of pesticides, herbicides and fertilisers. But, the comparatively less-used techniques of Remote Sensing and Spatial Analyses can provide value to integrated pest control approaches. The technologies are useful in the context of integrated pest management because they allow for a thorough understanding of the spatial complexity of a field's abiotic and biotic properties (through remote mapping or spatial modelling).

Remote Sensing

The acquisition of knowledge or information about items from a distance without coming into close contact with them is known as remote sensing. In 1921, remote sensing was first used to assess pest damage in forestry. From the perspective of remote sensing, an infrared and visible band in the electromagnetic (EM) spectrum are important. The infrared (IR) region's wavelength ranges from 3 µm to 3mm. Far IR, mid IR and near IR are the three types of IR (0.72-1.3 µm). The visible region's wavelength ranges from 0.4 to 0.7 µm. The emissive or thermal section of the EM spectrum is known as far IR because these rays heat the thing first, and then the object emits the rays. Mid-IR, near-IR, and visible portions of the spectrum, on the other hand, are collectively referred to as the reflecting portion of the spectrum since they are simply reflected by them. Three components form a remote sensing system: the signal, sensor and sensing. The signal is the reflected radiation from an object's surface. A sensor such as the human eye, a camera or any other instrument, detects the signal.

Types of Remote Sensing

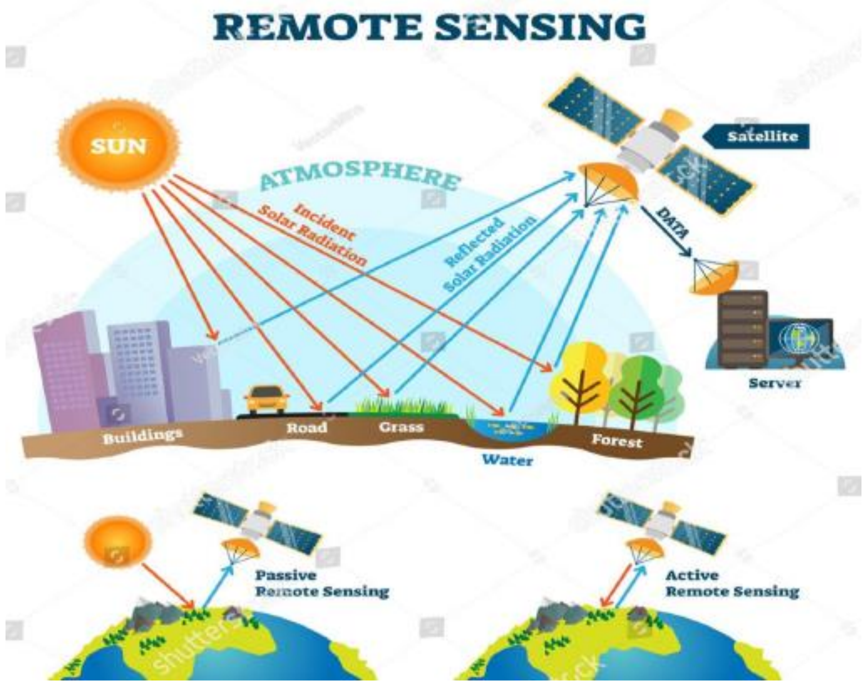

Fig. 1: Work flow of Remote Sensing (RS) technology

Active Remote Sensing System: An active remote sensing system includes a sensor as well as a light source that shines on the object being detected. In other words, it also contains the signal source, such as a camera with flash. It can detect the object using natural radiation in the sunlight but it must create radiation to irradiate the target in the dark.

Passive Remote Sensing: A sensor is the only component of passive remote sensing system. It doesn't emit radiations that would irradiate the thing being sensed. These can only see items when they are exposed to sunlight or electricity, but they do not emit radiation.

Remote Sensing Techniques Used for Pest Management

In the past few decades, remote sensing technology has advanced on two fronts:

1. Aerial Photography: Crop loss information has been collected in large part through the use of photography. Pest damage has also been photographed using panchromatic, colour infrared and black and white infrared films. The activity of insects is identified in aerial photography by the changes in the look of plant leaf. If insects leave deposits on leaves or cause changes in leaf colour, shape or density as a direct or indirect result of feeding, the foliage may be altered. In pictures, various type of damage can be spotted. Spruce budworm and other defoliators produce leaf thinning and discoloration from green to yellow and yellow to red. Aerial pictures can clearly demonstrate this. In the same manner, sucking insects damage trees, twigs and branches which can be seen in images. Some insects, such as aphids create honeydew on which the sooty mold fungus feeds. Aerial photography may easily spot the blackening of the foliage caused by this fungus. Aerial photography was used to investigate distribution of host plants of tropical fruit flies. Aerial photography is routinely used to monitor the post-harvest plant removal of cotton to prevent the outbreak of boll weevil, *Anthonomus grandis* in Texas.

2. Satellite based multispectral scanning: These gather data in the visible and infrared ranges of the electromagnetic spectrum. Non-photographic techniques are another term for them. Images can be formed over a far larger range of EM wavelengths (0.4-14 µm) than the photographic method. These do not produce a detailed overview of a scene in timely manner.

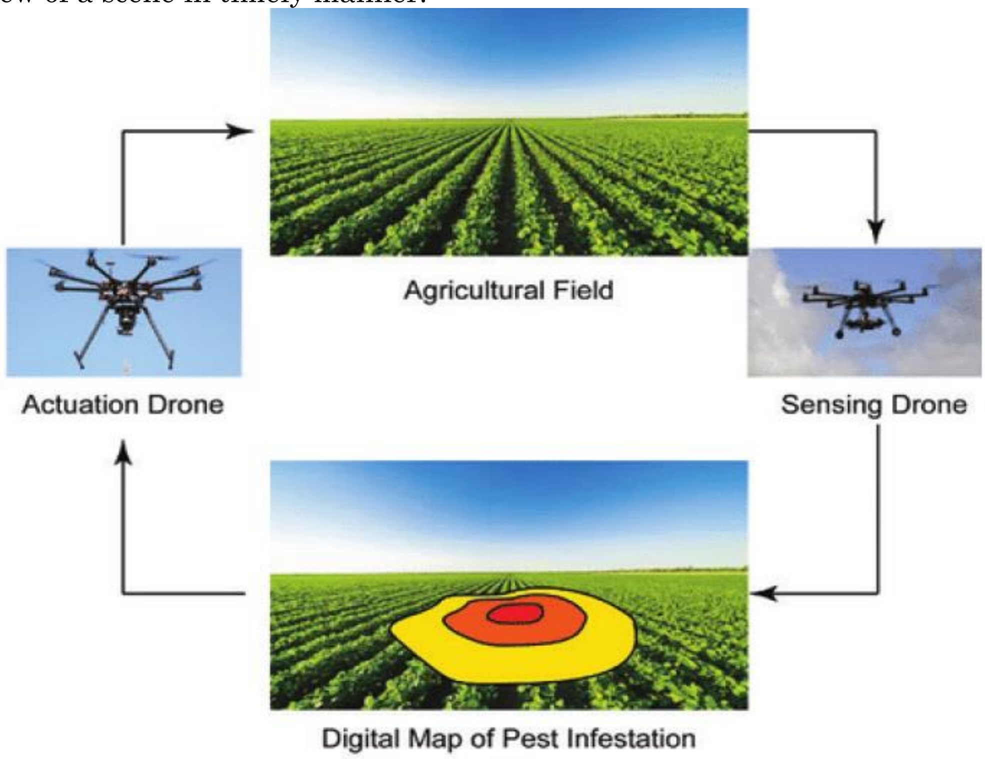

Fig. 2: Pest identification, digital mapping through RS and actuation of drone to spray the pesticides

These scanners on the other hand, use sensors with a very small field of view to scan an area in a systematic manner building up an image as the scan proceeds. IRS-1A and IRS-IB, the Indian Remote Sensing Satellite System gives images in the following bands: i) 0.45-0.52 µm ii) 0.52-0.59 µm iii) 0.62-0.68 µm iv) 0.78-0.86 µm. Satellite remote sensing is a great way to look into the environmental components that affect pest development, like rainfall and air temperature. Winds coupled with rainstorms bring armyworm flying moths, *Spodoptera exempta*, together. As a result, caterpillar epidemics become widespread. Data from Meteosat has been used to track these storms and swiftly pinpoint future outbreaks. Landsat data was used to identify locations with short-lived vegetation that could host the desert locust *Schistocerca gregaria*.

Application of Remote Sensing in Pest Management

Remote sensing can be considered as a fast, non-destructive and relatively cost-effective method to study biophysical and biochemical parameters of vegetation across vast spatial areas (Ngie *et al*., 2014). Remote sensing (including aerial photography) can supply baseline information for land-use and other forms of spatial planning in areas where maps are not available and it is used as an input for the modelling of alternative land use options (i.e., agriculture or biological conservation) (Leeuw *et al*., 2010). The application of remote sensing in pest monitoring, detection, early warning and management aspects in the field of agriculture are summarized as follows:

1. Survey of ecological conditions and forecasting locusts: The desert locust is found in Rajasthan, Gujarat and Haryana all of which are located in the world recession zone. Because of the favourable soil moisture, widespread rainfall, shade and lush vegetation in the recession area, locust breeding is successful resulting in destructive swarms.

Controlling locusts is a challenging task if action is not taken immediately. Satellite remote sensing provides vegetation index maps and rainfall estimates allowing researchers to keep a close eye on the population of desert locusts. The population of desert locusts and rainfall have been discovered to be closely related to the temporal (time related) and spatial (space related) distribution of desert vegetation. For the past four decades, the utilisation of satellite remote sensing technologies has created many hopes for locust surveillance.

The combined use of remote sensing data and RAMSES locust data over a 43-year period (1965-2008) proven to be significant. These locust data aided in the prioritisation of different areas based on their relevance to locust ecology. They allowed researchers to concentrate their efforts just on regions of high importance for this species prevention.

2. Assessment of crop infested with insect pests: Several remote sensing approaches have been developed to employ visible and infrared pictures to detect stress in rice production induced by BPH infestation. The use of remote sensing to detect insect infestations will spread, allowing precision farming to be practised.

ENVI 4.8 and SPSS software were utilised to conduct analyses utilising the Normalized Difference Vegetation Index (NDVI), Standard Difference Indices (SDI) and Ratio Vegetation Index (RVI). The threshold for zoning outbreaks might be clarified by using these indices as an indicator.

3. Whitefly monitoring and management: Cotton whitefly (*Bemisia tabaci)* has caused havoc on the cotton crop in numerous parts of India. Both adults and nymphs suck sap from plants causing leaf yellowing and shedding, as well as a decrease in boll production.

The fungus sooty mould grows on the insect's honeydew as a result photosynthesis and lint quality suffer. Remote sensing was used to detect a whitefly-infested cotton crop. The cotton crop was assessed using Landsat fake colour composites. Whitefly-affected areas with moderate (50 % crop loss) and severe (80 % crop loss) crop loss were easily detected.

Conclusion

In remote and inaccessible places, remote sensing has been utilized to provide vital information on crop status and the detection of insect population development. Its goal is to fill in gaps in existing systems by ensuring a consistent flow of information regarding areas afflicted by insect pests, diseases and other yield-reducing factors across the country.

Based on research findings on some crop pests and diseases, GIS and RS can be used in agriculture insect pest management decisions, timely planning and getting different information in many specific areas. Insect pest forecasting in the agro-ecosystem allows farmers to be informed about potential outages, allowing them to be prepared and take appropriate action to use biocontrol agents, mechanical means and pesticides, lowering production costs and serving as a tool in precision farming. As a result, recent breakthroughs in the field of remote sensing open up a lot of possibilities for using this technology in agriculture for pest monitoring, detection and precise management.

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Pyramiding of Genes and their Expression

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Bansuli[1], Seethiya Mahajan[2], Divya Tandon[3]
[1,2]Assistant Professor, Department of Agriculture, Khalsa College Amritsar, Punjab.
[3]Assistant Professor Shoolini Institute of Life Sciences and Business Management, Solan, Himachal Pradesh.

Gene pyramiding is a method aimed at assembling multiple desirable genes from multiple parents into a single genotype. The end product of a gene pyramiding program is a genotype with all of the target genes.

Objectives of Gene Pyramiding

1. Enhancing trait performance by combining two or more complementary genes.
2. Remedying deficits by introgressing genes from other sources.
3. Increasing the durability of disease and/or disease resistance.
4. Broadening the genetic basis of released cultivars.
5. Traditionally, gene pyramiding is mainly used to improve qualitative traits such as disease and insect resistance.
6. Widely used for combining multiple disease resistance genes for specific races of a pathogen.
7. Main use is to improve existing elite cultivar.
8. Eliminates extensive phenotyping.
9. Control linkage drag.
10. Reduces breeding duration.

Types of Gene Pyramiding

1. Conventional technique: Serial gene pyramiding: Genes are deployed in same plant one after other.
2. Molecular technique: Simultaneous gene pyramiding: Genes are deployed at a time in a single plant.

A Distinct Gene Pyramiding Scheme

Generation of a population of doubled haploids from the root genotype is a possible procedure for the fixation steps. Here, a population of gametes is obtained from the genotypes and their genetic material is doubled. This leads to a population of fully homozygous individuals, among which the ideotype can be found.

Using this process, the ideal genotype can be obtained in just one additional generation after the root genotype is obtained. However, producing large population of doubled haploid is difficult and cumbersome in certain plant species. A possible alternative to this method is to self the root genotype directly to obtain the ideal genotype.

However, selfing the root genotype will result in the breakage of linkage between the desired alleles and it will be difficult to derive this break as the linkage phase is rarely visible in selfed populations. As a result, it may span too many generations thereby stretching the gene pyramiding scheme.

Another alternative to all these methods would be to obtain a genotype carrying all favorable alleles in coupling by crossing the root genotype with a parent containing none of the favorable alleles. This confirms that the linkage phase of the offspring is known and the genotype can be derived without any mixing. The ideal genotype will be reached within two generations after the root genotype.

However, instead of crossing with a blank parent, a more simplified method would be to cross the root genotype with one of the founding parents. In such programs, the linkage will still be known and the selection will be for genotypes that are homozygous for the target gene brought by the founding parent but heterozygous for other regions. The desired genes need not be fixed subsequently, thereby increasing the probability of getting the ideal genotype. This is called as marker assisted backcross gene pyramiding. By far this is the most accepted and efficient method to do the gene pyramiding. Different types of pyramiding are shown in the Figure 1.

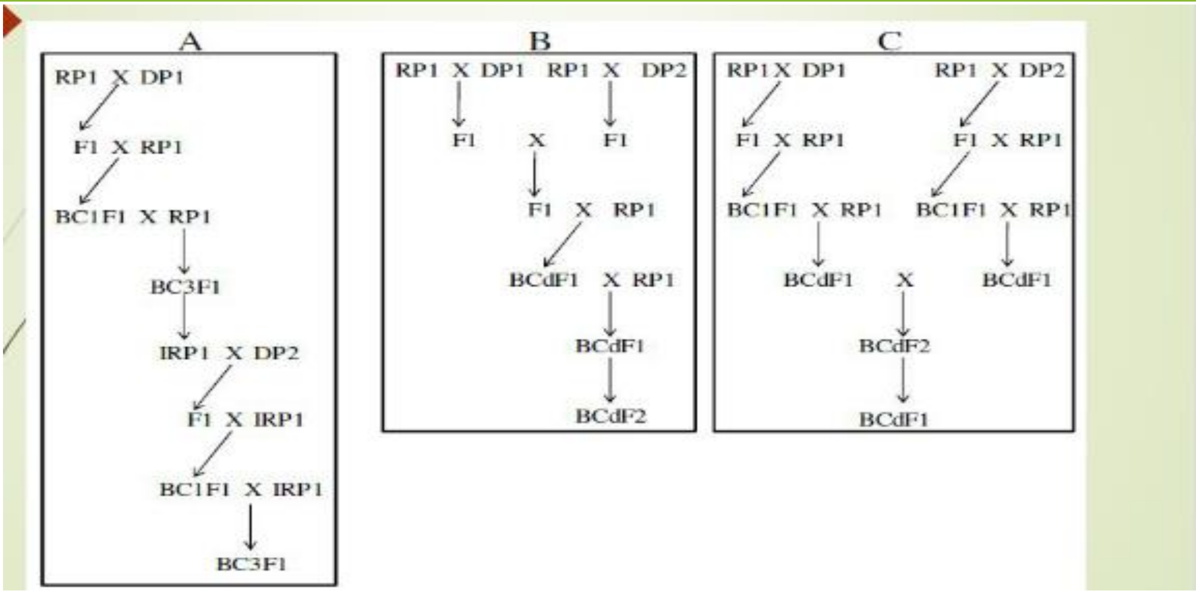

Figure 1 Different schemes of backcrossing for gene pyramiding (A: Step wise transfer B: Simultaneous transfer C: Simultaneous and Step wise transfer)

Marker-Assisted Backcrossing

Marker-assisted breeding allows breeders to identify young plants with the desired trait and by facilitating the removal of stray donor genes from intermediate backcrosses. The result, in about two years, is an improved variety exactly like the popular cultivar except that it possesses the transferred advantageous gene. In principle, this technique can be applied to the breeding of any crop or farm animal. So far, however, breeders of trees and rice have dominated the field. Because markers allow breeders to select immature plants, the time saved in breeding slow-growing trees is immense. In the case of rice, the crop's relatively advanced state of genetic mapping has facilitated the application of molecular marker techniques. Markers are effective aids to selection in backcrossing in three ways. First, markers can aid selection on target alleles whose effects are difficult to observe phenotypically. Examples include recessive genes, multiple disease resistance gene pyramids combined in one genotype (where they can epistatically mask each other's effects), alleles that are not expressed in the selection environments (e.g., genes conferring resistance to a disease that is not regularly present in environments), etc. Second, markers can be used to select for rare progeny in which recombination near the target gene have produced chromosomes that contain the target allele and as little possible surrounding DNA from the donor parent. Third, markers can be used to select rare progeny that are the result of recombination near the target gene, thus minimizing the effects of linkage drag. In general, the marker assisted backcross-based gene pyramiding can be performed in three strategies. In the first method, the recurrent parent (RP1) is crossed with donor parent (DP1) to produce the F1 hybrid and backcrossed up to third backcross generation (BC3) to produce the improved recurrent parent (IRP1). This improved recurrent parent is then crossed with other donor parent (DP2) to pyramid multiple genes. This strategy is less acceptable as it is time taking but pyramiding is very precise as it involves one gene at one time. In the second strategy, the recurrent parent (RP1) is crossed with donor parents (DP1, DP2, etc.) to get the F1 hybrids which are then intercrossed to produce improved F1 (IF1). This improved F1 is then backcrossed with the recurrent parent to get the improved recurrent parent (IRP). As such, the pyramiding is done in the pedigree step itself. However, when the donor parents are different, this method is less likely to be used because there is chance that the pyramided gene may be lost in the process. The third strategy is an amalgamation of the first two which involve simultaneous crossing of recurrent parent (RP1) with many donor parents and then backcrossing them up to the BC3 generation. The backcross populations with the individual gene are then intercrossed with each other to get the pyramided lines. This is the most acceptable way as in this method not only time is reduced but fixation of genes is fully assured.

Marker assisted backcrossing to be effective, depends upon several factors, including the distance between the closest markers and the target gene, the number of target genes to be transferred, the genetic base of the trait, the number of individuals that can be analyzed and the genetic background in which the target gene has to be transferred, the type of molecular marker(s) used, and available technical facilities. When these entire selection criterions are maintained properly, only then a well acceptable MAB based gene pyramiding scheme can lead to durable crop improvement.

Advantages of Gene Pyramiding

1. Gene pyramiding is an important strategy for germplasm improvement.
2. Pyramiding requires that breeders consider the minimum population size that must be evaluated to have a reasonable chance of obtaining the desired genotype.
3. Gene pyramiding with marker technology can integrate into existing plant breeding programme all over the world to allow researchers to access, transfer and combine genes at a rate and with a precision.
4. MAS based gene pyramiding has the potential to increase the rate of genetic gain when used in conjunction with traditional breeding.

Disadvantages of Gene Pyramiding

1. Greater the number of genes, more plant proteins will be diverted away from creating useful yield.
2. This scenario sets the risk of significant agronomic and yield penalties which make the variety unattractive to grower.
3. One toxin can bind to several sites. Such a scenario can lead to the development of cross resistance or multiple resistance of an insect in case where it was never exposed to the origin toxin.

Water Management in Multiple Cropping System

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Kavita Solanki[1], Saransh Saxena[2]

[1]Ph.D. Research Scholar, Department of Agronomy, PG College of Agriculture, Dr. RPCAU, PUSA, Samastipur, Bihar – 848125.

[2]Ph.D. Research Scholar, Department of Horticulture, College of Agriculture, JNKVV, Jabalpur, M.P. – 482004.

Summary

Growing populations and unsure climate changes can place high demands on water resources within the future. holistic approaches and integrated management principles are required to develop property systems and stop disasters. Agricultural water management should be integrated with alternative water management practices (Singh et al., 2014).

Water like soil, could be an important resource in terms of utilization and management for achieving higher crop production. Management of water in agriculture deals with utilizing water effectively beneath totally different soil and atmospheric condition.

Effectiveness in water saving, equity in water sharing and delivery potency are essential for the property use of obtainable water resources. To make water resource sustainable, there is urgent need for an integrated water management (IWM) system which includes policy and management actions. Judicious utilization of all water resources either single or in combination controlling wasteful losses and using conservation technology leading in efficient moisture utilization.

Introduction

Multiple cropping is common and a widespread land use management strategy in low-land tropical and subtropical agriculture where rainy seasons are long enough or irrigation is viable. Besides the direct benefit for crop production by increasing the number of harvest and the amount of biomass extracted, multiple cropping can improve the functioning of agricultural systems and reduce the environmental consequences sometimes associated with crop production (Gaba *et al.*, 2015).

The longitudinal analysis of cropping pattern across farm households and villages has revealed that the adoption of drip irrigation is motivated by many factors. The two major constraints limiting agricultural production are: human labour and water scarcity. These two factors had forced the farmers to modify their cropping pattern towards less labour and water-intensive crops. The resource-poor farmers were going in for rainfed crops like sorghum, maize, etc. However, the big farmers who had access to capital, were adopting various water management and cropping strategies.

Practices and Strategies for Increasing Irrigation Water Productivity

The productivity of irrigation water can be enhanced by doing one of the following: increasing the value of output per unit of water transpired (T); reducing losses to evaporation (E); reducing losses due to seepage (S) and percolation (P); reducing surface runoff (R); or reusing or recycling water, either within the system or elsewhere in the basin. A range of alternative practices and their potential effects on one or more of the above are described below-

1. Developing improved varieties: The use of early-maturing, high-yielding varieties over the past three decades has led to a rapid growth in output per unit of land and water. Advances in biotechnology could facilitate further improvement of varieties with tolerance to drought, salinity and cold temperatures, leading to a further increase in output per unit of T.

2. Improving agronomic management: Introducing optimum combinations of improved technologies or management practices, such as pest control and nutrient management, conservation practices can raise crop yields and output per unit of T.

3. Changing the crop planting date: The rate of evaporation varies between wet and dry zones and, within a given location, between wet and dry seasons. By planting in time, it is possible to avoid the months of high losses to evaporation (E) before canopy closure.

4. Reducing water use for land preparation: The land preparation period, which currently lasts more than a month in many areas and accounts for as much as one-third of the water diverted, can be reduced to a few days. This might require using more field channels instead of plot-to-plot water delivery and a change in land preparation practices including dry tillage. The result would be a substantial reduction in losses caused by E.

5. Water distribution strategies: Particularly in the dry season, it may be impossible to achieve an even distribution of water over the upper, middle and lower reaches of a system with rotation, which would reduce losses to S&P and provide water to a larger area. Several forms of irrigation rotation are possible according to the level in the system, the time schedule, etc.

6. Enhancing water-use efficiency crops: Water-use efficiency (WUE) crops can be improved by selection of crops and cropping systems based on available water supplies and increasing seasonal evapotranspiration (ET). The later can be achieved by selection of irrigation method, irrigation scheduling, tillage, mulching and fertigation. The average WUE of different crops varies from 3.7 to 13.4 kg/ha per mm of water.

Crop	WUE (kg grain/ha per mm of water)
Rice	3.7
Finger millet	13.4
Wheat	12.6
Sorghum	9.0
Maize	8
Groundnut	9.2

7. Selection of crops and cropping system: Selection of crops and cropping systems for high water-use efficiency should be done on the basis of availability of water under rainfed crops, limited irrigation crops and fully irrigated crops.

a. Rainfed crops - The amount of rainfall converted into plant-available soil water is determined by the amount and intensity of rainfall, topography, infiltrability and water rententivity of soil, depth of root zone and soil depth. On medium soil depth monocropping or intercropping can be practiced whereas in deep soil with 200 mm available soil moisture status double cropping can be practiced.

b. Limited irrigated crops - Selection of crops and cropping sequences under limited irrigation situation should be done as there should be minimum water stress during the growing season. Therefore, along with selection of crops special care should be taken for irrigation scheduling of these crops.

c. Fully irrigated crops - Under fully irrigated condition selection of crops is not constrained by water availability but by adaptability of the crops to prevailing climatic and soil conditions. In general, water use efficiency of C_4 plants is higher than C_3 plants, particularly under semi-arid environment.

8. Increasing seasonal evapotranspiration: Seasonal evapotranspiration (ET) is a measure of consumptive water use by the crops. Increasing the transpiration (T) component of ET, results in higher utilization of water by the crops to increase the productivity. The T can be increased by following improved irrigation methods, irrigation scheduling, tillage, mulching and fertigation.

a. Irrigation method - Efficient micro-irrigation methods and technologies like sprinkler and drip irrigation for utilization of available water in case of scarce is developed mainly for high value horticultural and plantation crops could save upto 50% of water and also increase the crop yield and quality substantially.

b. Drip irrigation is often preferred over other irrigation methods because of the high water-application efficiency on account of reduced losses, surface evaporation and deep percolation. Improved water use efficiency under drip irrigation, by reducing percolation and evaporation losses, provides for environmentally safer fertilizer application through the irrigation water (Mmolawa and Or, 2000).

Application Efficiencies of Major Irrigation Methods

Irrigation method	Application efficiency (%)
Basin irrigation	58
Graded border irrigation	53
Furrow irrigation	57
Sprinkler irrigation	67
Drip irrigation	80

Average values of water use efficiency and water saving percentage in drip over the conventional irrigation system for various crops (Saxena and Rao, 2019).

Crop	Water Productivity (kg m^{-3})	Water Saving (%)
Baby corn	4.8	43.8
Banana	29.5	42.5
Brinjal	14.7	42.5
Chickpea	16.0	42.6
Coconut	68.9	50.5
Cotton	8.6	51.1
Grape	9.5	43.0
Groundnut	10.0	32.4
Guava	35.3	9.0
Maize	22.0	45.0
Mango	24.0	28.9
Okra	19.4	44.7
Papaya	9.1	67.9
Potato	28.0	24.6
Sugarcane	11.9	46.6
Tomato	38.2	37.3

1. Irrigation scheduling: Under adequate water availability the main emphasis is on securing potential yield of the crops without wasting water. Whereas, under limited water supply, the objective is to achieve maximum water use efficiency (WUE). There are different methods for irrigation scheduling viz., critical crop growth stages, feel and appearance method, soil moisture depletion approach, irrigation water at different cumulative pan evaporation method (IW/CPE) etc.

2. Tillage: Tillage affects the WUE by modifying the hydrological properties of the soil and influencing root growth and canopy development of crops. Tillage system suitable for a soil depends upon soil type, climate and cropping system practiced. Shallow inter-row tillage into growing crops reduces short term direct evaporation loss from soil. Deep tillage to a depth of 30-45 cm at 60-120 cm intervals helps in breaking subsoil hard pans facilitating growth and extension of roots and improving grain yield of crops as well as increase in the residual soil moisture.

3. Mulching: Mulching influences water use efficiency of crops by affecting the hydrothermal regime of soil, which may enhance root and shoot growth, besides it helps in reducing the evaporation (E) component of the evapotranspiration. Under moisture stress conditions, when moisture can be carried over for a short time or can be conserved for a subsequent crop, mulching can beneficial in realizing better crop yield. The crop residues acted as mulch and helps in water retention, increase minimum and decrease maximum soil temperatures, increase water infiltration rate, decrease evaporation, increase crop yields and water productivity.

4. Fertigation: The application of fertilizers, soil amendments, or other water-soluble products through an irrigation system is fertigation. There is strong interaction between fertilizer rates and irrigation levels for crop yield and water use efficiency. Application of nutrients facilitates root growth, which can extract soil moisture from deeper layers. Furthermore, application of fertilizers facilitates early development of canopy that covers the soil and intercepts more solar radiation and thereby reduces the evaporation component of the evaporation. Fertigation enables adequate supplies of water and nutrients with precise timing and uniform distribution to meet the crop nutrient demand.


Optimal Allocation of Water

Optimal allocation of available water among the competing crops and optimum timing of application is to be decided under adequate and limited water supply situation so as to maximize economic returns from available water. Under adequate water supply situation optimal allocation involves timing of irrigations so that crop yields are maintained at their achievable potential, as per climatic conditions of the location. Under limited water supply situation irrigation water must be allocated so that periods of possible water deficits coincide with the least sensitive growth periods.

How to use irrigation water efficiently:

a. Conveying the water from the source to the field with minimum loss.
b. Following right method of irrigation.
c. Applying water to the crop at the right time.
d. Applying water in proper amount.
e. Selecting right type of crop, varieties that are high yielding.
f. Grow crop that requires less water in areas where availability is scarce.
g. Mulching to reduce evaporation.

Conclusion

Conservation tillage practices unremarkably stores a lot of plant available moisture than the conventional inversion tillage practices. The high soil moisture content beneath conservation tillage is due to both improved soil structure and reduced evaporation loss due to crop residue mulch cover. Increase in the available water content under conservation tillage, particularly in the surface horizon, increases the consumptive use of water by crops and hence improves the water use efficiency. Effectiveness in water saving, equity in water sharing and delivery efficiency are essential for the sustainable use of available water resources.

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Use of Low-Cost Treadle Pump for Lift Irrigation in Crop Production

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S. Roma Devi[1], Laishram Kanta Singh[2], Lydia Zimik[2]

[1]ICAR-KVK Churachandpur, ICAR Research Complex for NEH Region, Manipur Centre, Lamphelpat, Manipur-795004, India.

[2]ICAR-KVK Imphal West, ICAR Research Complex for NEH Region, Manipur Centre, Lamphelpat, Manipur-795004, India.

With the advent of the treadle pump in the developing world during the last decade, a tiny but important revolution in small-scale irrigation has occurred. In rural workshops in underdeveloped nations, this basic, human-powered gadget may be made and maintained at a minimal cost. It has been regarded as having an unusual level of acceptability in Bangladesh, where it was initially created in the early 1980s. In that country, almost 5,00,000 pumps are presently in operation on a regular basis. Today, electricity is a lifeline for the majority of people. However, many people in India and elsewhere continue to live with limited or no access to power. There is no one line that can sum up the importance of agriculture in any country when considering one group of people: agricultural farmers. Agriculture is the backbone, if not the sole, source of income for rural residents. This is especially true in backward, distant, and interior locations that are far apart from the rural areas found near large towns and cities. Such backward places may even be without electricity or have power solely for show. All of the residents are impoverished, marginal farmers who rely on natural and seasonal rains to sustain their livelihoods. They can only produce seasonal crops for a portion of the year due to the rains. They remain powerless and inactive for the rest of the year, which pushes them farther into poverty. Thus, treadle pump irrigation technology aids farmers in escaping poverty or maintaining their non-poverty status.

A treadle pump is a human-powered suction pump that stands on top of a well or some other kind of water source for irrigation. The pumping is activated by stepping up and down on a treadle, which are levers that drive pistons and generate cylinder suction, which draws groundwater/storage water to the surface. Treadle pumps assist farmers optimize the yield on their small areas of land by removing their reliance on rain-fed irrigation. The treadle pump may perform most of the functions of a motorized pump at a fraction of the cost. Pumps cost between Rs. 1500 and Rs. 7000, including installation. It can also be 50% less expensive to operate than a motorized pump because it does not require fossil fuel (it is powered by the operator's body weight and leg muscles). It can extract water from wells and reservoirs up to the depth of 15 ft and can deliver upto the height of 45 ft, as well as from lakes and rivers at a rate of two to five cubic metres per hour.

Farmers generally utilise treadle pumps on small areas of land, typically less than an acre in size. They are also adopted in developing countries and modest places in Africa as well as Asia and everywhere else where economically weaker section. When compared to other traditional irrigation systems, the treadle pump may significantly increase the money that farmers generate from their land by expanding the number of growing seasons, broadening the types of crops that can be produced, and improving the quality of farm products.

Treadle Pump Available in India

KB Surface Treadle Pump: The KB Surface Treadle Pump is a foot-operated reciprocating type positive displacement pump that uses an open channel water delivery system to take water from a surface water source such as a dug well, ponds, or canal.

Applications:

1. Irrigation on a small scale.
2. Widely adaptable to a variety of crops (vegetables, cereals, cash crops, spices, medicinal, aromatic, flowers).

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3. Irrigation is appropriate for all crops in areas up to 0.4 hectares (4000 sq m).

Lift irrigation using IDE treadle pump for crop production
(Sources: http://ide-india.org/content/kb-surface-treadle-pump)

Table 1. Specifications of KB surface treadle pump:

Sl. No.	Description	Specifications
1.	Constructional Material	CRC (Cold Rolled Coil) sheet and mild steel
2.	Pump Type	3.5-inch diameter (each) twin barrels
3.	Maximum Stroke Length	100 mm
4.	Weight	18 Kg
5.	Operator's weight	Operates easily with 35-40 Kg operator's body Weight.
6.	Maximum Suction Lift	8 meters
7.	Delivery System	Open channel flow at atmospheric pressure.
8.	Pedalling System	A pair of metal pedals integrated with counter weight, foot rest and bush bearing provides ease of operation & smooth pedals movement.
9.	Stability	Tripod base is provided to have better stability & easy shifting.
10.	Suction pipe size	1.5" (38 mm) diameter flexible PVC suction hose pipe. One end of the suction pipe is essentially to be submerged underwater.
11.	Maximum Flow	4500 litres per hour
12.	Water Quality	Resistant to silt particles but not suitable for saline water (EC>4dS/m).
13.	Durability	8-10 Years

***(Sources: http://ide-india.org/content/kb-surface-treadle-pump)**

Ecoflo Treadle Pump

The treadle pumps first appeared in Bangladesh in 1985, and the Ecoflo Treadle pump is based on them. The typical treadle pump's metal working parts are replaced with plastic components, making the Ecoflo Treadle Pump unique and one of a kind. The Ecoflo Treadle pump is rust-free and lightweight since all of its working components are made of sturdy and strong plastic. The Ecoflo pump can suction water from a maximum depth of 15 feet, lift it up to 45 feet to fill an overhead tank, and carry it up to 1 kilometre. This pump can easily pump 5000 litres/hour. The Ecoflo treadle pump is less than 12 kg in weight and can be easily transported to any location.


Operation of Treadle Pump at Ngairangbam Village

The Ecoflo treadle pump is ideal for assisting marginal farmers water their plots. Suction of water, lifting of water, conveying water, and irrigating their plot are all difficulties that an Ecoflo treadle pump can readily address for a typical marginal farmer. Farmers will be able to plant in the dry season and develop out of poverty once irrigation is available. As a result, the Ecoflo treadle pump is cheaply priced to appeal to marginal farmers.

Accessories (for Proper Usage of the Ecoflo Pump)

1. Nipple and delivery pipe (2").
2. Suction pipe and outer nipple (1.5″).
3. Foot valve with nipple.

Ecoflo Treadle Pump with Mini Sprinkler Kit

The Ecoflo treadle pump can irrigate an area of up to 500 m^2 with 12 sprinklers.

Ecoflo Treadle Pump with Inline Drip Kit

The Ecoflo treadle pump can irrigate a plot of up to 500 square metres with 25 metres of 20 inline rolls spaced at 1 metre intervals. It can also irrigate a plot of land larger than 500 m^2 by interchanging the plot's output pipes.

Conclusion

For the first time in Manipur, a manual water lift treadle pump was introduced in Ngairangbam village, Imphal West, Manipur, as front line demonstration program (FLD) under KVK Imphal West, ICAR Manipur Centre during this COVID Pandemic. The program was successfully launched on 26th May 2020. The technology demonstrated will help in providing lift irrigation facilities in the water scares areas to irrigate different high-value crops without uses of any external energy. This pump can easily run @ litres/hour. The treadle pump weighs just 12 kg and can be ported to any place with minimum efforts. The treadle pump works on a simple stepping motion. Hence, it runs without electricity and zero operational cost. This makes the treadle pump suitable for marginal farmers helping them to irrigate their plots. For a typical marginal farmer, problems like suction of water, lifting of water, transporting water and irrigating their plot can be easily solved by a treadle pump. Once irrigation is possible, farmers can cultivate in dry-season and can improve their income. The treadle pump can be used for any application where pumping of water is necessary, in case of sudden power-cuts, emergency water pumping, load-shedding, etc. The treadle pump can be a quick solution wherein it can be carried to any place and operated with minimum physical efforts.

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Plastic Mulching for Crop Production

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J. Rakesh[1], Dr. S. Sravanthi[2]

[1]Ph.D(Ag.) Scholar, Department of Agronomy, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal-741252.

[2]Research Associate, Department of Agronomy, Krishi Vigyan Kendra, Rastakuntabai, Vizianagaram, Andhra Pradesh.

Introduction

Mulching is the process or practice of covering the soil/ground to make more favourable conditions for plant growth, development and efficient crop production. Mulch technical term means 'covering of soil'. While natural mulches such as leaf, straw, dead leaves and compost have been used for centuries, during the last 60 years the advent of synthetic materials has altered the methods and benefits of mulching. The research as well as field data available on effect of synthetic mulches make a vast volume of useful literature. When compared to other mulches plastic mulches are completely impermeable to water; it therefore prevents direct evaporation of moisture from the soil and thus limits the water losses and soil erosion over the surface. In this manner it plays a positive role in water conservation. The suppression of evaporation also has a supplementary effect; it prevents the rise of water containing salt, which is important in countries with high salt content water resources.

Advantages of Plastic Mulching

1. It is completely impermeable to water.
2. It prevents the direct evaporation of moisture form the soil and thus limits the water losses and conserves moisture.
3. By evaporation suppression, it prevents the rise of water containing salts.
4. Mulch can facilitate fertilizer placement and reduce the loss of plant nutrient through leaching.
5. Mulches can also provide a barrier to soil pathogens
6. Opaque mulches prevent germination of annual weeds from receiving light
7. Reflective mulches will repel certain insects
8. Mulches maintain a warm temperature even during night time which enables seeds to germinate quickly and for young plants to rapidly establish a strong root growth system.
9. Synthetic mulches play a major role in soil solarisation process.
10. Mulches develop a microclimatic underside of the sheet, which is higher in carbondi-oxide due to the higher level of microbial activity.
12. Early germination almost 2-3 days.
13. Water erosion is completely averted since soil is completely covered form bearing action of rain drops.
13. When compared to organic mulches, it serves for a longer period.

Plastic Mulching

Limitations

1. They are costly to use in commercial production when compared to organic mulches.
2. Probability of 'burning' or 'scorching' of the young pants due to high temperature of black film.
3. Difficulty in application of top-dressed fertilizer.
4. Reptile movement and rodent activities are experienced in some places.
5. More runoff.
6. Environmental pollution.
7. Difficult in machinery movement.
8. Cannot be used for more than one season using thin mulches.
9. Weed penetration with thin films.

Importance of Parameters of the Plastic Film

1. Thickness: Normally the thickness of the film does not affect the mulching effect except when it is used for solorisation. But some of the recent references do indicate the impact of film thickness on crop yield. Since it is sold by weight it is advantageous to use as thin a film as possible but at the same time due consideration should be given for the longevity of the film. The early mulch film used were of 60–75-micron (240-300 gauge) thickness, and today it is possible to have 15-micron thick film due to advent of film extrusion technology. These films are mechanically weak, as shown by their easy tearing when pulled tension.

2. Width: This depends upon the inter row spacing. Normally a one to one and half meter width film can be easily adopted to different conditions.

3. Perforations: The perforations may be advantageous under some situations and disadvantageous for some other situation. The capillary movement of water and fertilizer distribution will be better and more uniform under unperforated condition. But for prevention of water stagnation around the plants, perforation is better. But it has got the disadvantages of encouraging weed growth.

4. Mulch colour: The colour of the mulch affects:

- a. Soil temperature.
- b. Temperature of air around the plants.
- c. Soil salinity.
    - i. Due to lesser quantity of water used.
    - ii. Due to reduction in evaporation and prevention of upward movement of water.

Selection of Mulch

The selection of mulches depends upon the ecological situations and primary and secondary aspects of mulching:
Rainy season - Perforated mulch.
Orchard and plantation - thicker mulch.
Soil solarisation - Thin transparent film.
Weed control through solarisation - Transparent film.
Weed control in cropped land - Black film Sandy soil - Black film.
Saline water use - Black film.

Irrigation Practices Under Mulching

1. In drip irrigation the lateral pipelines are laid under the mulch film
2. In case inter-cultivation need to be carried out, it is better to keep the laterals and drippers on top of the mulch film and regulate the flow of water through a small pipe or through the holes made on the mulch film.

In flooding the irrigation water passes through the semi-circular holes on the mulch sheet.

Weed Control

1. Black plastic film does not allow the sunlight to pass through on to the soil.
2. Photosynthesis does not take place in the absence of sunlight below black film hence; it arrests weed growth.

Cost Economics of Mulching

The cost economic of mulching is an important aspect. In a leveled field if mulching is to be done, then the film area required will be almost equal to that of field itself. In fields with ridges and furrows mulching material required will be sizably more than the field area. However, mulching is carried out in strips covering 50-60% of field area. In the present era of minimizing rainfall conserving moisture with mulching transgresses the plan of economic analysis in the sense that the real cost analysis would be even meaningless in the case of a precious commodity like water. A typical calculation has been given for working out cost economics of mulching in Bhendi crop.

Some Experiments Results

1. Flexible PVC film is suitable for mulching. PVC film shows the expected over all advantages of mulch irrigation such as conservation of moisture and control of weed growth.
2. Savings in water appear to be the main advantage and such savings are found to vary from 20% to as high as 75%. The savings in water are more pronounced in arid areas. These experiments clearly established that such savings could be of critical importance in arid areas.
3. Yields of crops may not necessarily be substantially increased directly by usage of mulching, but more land can be cultivated with the available amount of water and thus overall cultivation of crops can be increased.

Conclusion

Plasticulture is crucial to Indian agriculture in view of the changing technological scenario for boosting crop yields and productivity. Introduction of linear low-density polyethylene (LLDPE) as a mulch film has brought a revolution in agricultural water management. It is actually a boon to dryland farmers. This is one of the fastest growing plasticultural applications in the world. The cost of LLDPE film is also lesser than one third of LDPE mulch film.

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Leaf Color Chart: An Effective Tool for Nitrogen Management

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Chaithra C.[1]
[1]M.Sc. (Agri), Department of Agronomy, UAS, GKVK, Bangalore, Karnataka-560065.

Fertilizer N is as one of the key inputs in cereals, in particular rice production in India. Amongst the nutrient management techniques, Nitrogen management is the main concern in rice production. N holds a distinguishing prominence amongst the nutrient elements and is known as the "mineral of life" for rice. It is the utmost needed input that restricts rice production in irrigated environment. The continuous use of high levels of chemical fertilizers is adversely affecting the sustainability of agricultural production and causing environmental pollution. In order to maintain food security, agricultural profitability and environmental quality, fertilizer nitrogen (N) use efficiency in cereal-based agriculture foods to be improved substantially. In most of the cereals crops in India, fertilizer nitrogen has been managed generally following blanket recommendations consists of fixed rate and timing of two or three pre-set split applications of the total nitrogen. Due to large field to field variability of soil nitrogen supply, efficient use of fertilizer N is not possible by following blanket application of fertilizer N. The main reason for low nitrogen uses efficiency is inefficient splitting of N applications and use of N in excess to the requirements, which is analogous with uncertainty faced by the farmers in deciding fertilizer N to be applied. The concentration of nitrogen in leaf (LNC) is highly correlated with chlorophyll content and it can be measured using devices like leaf colour chart (LCC), SPAD, at LEAF+ of chlorophyll or nitrogen. As the devices are expensive and unavailable with all farmers, LCC provides prospects to the farmers for estimating plant N requirement in actual time for effective fertilizer use and augmented rice yields

Leaf Color Chart is a diagnostic tool for monitoring the relative greenness of a rice leaf as an indicator of the plant N status, a plastic ruler - shaped strip containing four/more panel that range in colours from yellowish green to dark green.

Fig.1: Leaf Color Chart (LCC)

Eco-Friendly Tool

Successful adoption and use of LCC would promote timely and efficient use of N fertilizers in rice and wheat and some costly fertilizers and minimize the fertilizer related pollution of surface and ground water. Thus, LCC is a promising eco-friendly and inexpensive tool in the hands of farmers which indicates a close link between chlorophyll and N content of leaf hence can be used as a quick and reliable tool for assessment of leaf N status of crop at different crop growth stages. It contains gradients of green colour from yellowish green to dark green based on wavelength characters of rice leaves and can guide for N top dressing.

Advantages

1. LCC is an uncomplicated and effortless tool for the farmers to measure nitrogen status of the leaf and to identify the instance for top dressing of N to paddy.
2. LCC based nitrogen application enhances productivity and profitability of transplanted rice.

3. Reduce the excessive application of N fertilizer by farmers.
4. Reduce NO, pollution in ground water.
5. It is inexpensive and portable thus, making it easy to carry to field for estimating N status of the leaf.
6. It is a non-destructive thus avoids leaf sampling, laboratory analysis, and delay in receiving results method.
7. Any specific knowledge or skill is not required for using LCC because it depends only in comparing the colour and computing the scale of the leaf with standard chart.

Demerits

1. LCC fail to identify minor variations in leaf greenness as the colour shades lies in between two shades.
2. The comparative accurateness of LCC to measure the leaf N status can be estimated only when it is equated and interrelated with chlorophyll meter readings and adjusted accurately with the plant groups.
3. LCC is resorted only to adjust the top-dressed N but fail to adopt the basal N appliance by LCC.
4. LCC can be better suited in site-specific nutrient management approach wherein to realise optimal reaction to N fertilizer, other nutrients need not be restricting.
5. Hence, sufficient levels of other nutrients need to apply on basis of soil tests results.
6. P or K deficits make dimmer leaf colour leading to inaccurate LCC interpretations.

Conclusion

It is can be concluded that leaf colour chart (LCC) is a stress-free, user friendly and economical tool for assessing chlorophyll content of rice leaf. LCC centric nitrogen supervision aids farmers to assess the actual time N requirement of the crop and guarantees N saving without conceding their production. These tools are inevitable guidelines in deciding the top-dressed N requirements and synchronize fertilizer N application with actual crop need. Thus, LCC proves best over the conventional method of N estimation which is very tedious and emphasis over based N application to the crops.

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Diseases of Gerbera and their Management

Article ID: 35113

Swapnil Raghatate[1]
[1]Ph. D. Scholar, Department of Floriculture and Landscape Architecture, Dr. PDKV, Akola (M. S.).

Foot Rot and Root Rot

This is a serious disease of gerbera and it is caused by the fungus *Phytophthora, Pythium* and *Rhizoctonia solani*. The disease is caused by soil borne fungi in combination or singly. The stem gets infected and turn black, rot, leaves and flowers die.The water logged and high humidity condition favoured the growth of pathogen and incidence of this disease occurs.

Management: The treatment of captan (0.2%), use of healthy planting material, good sanitation and proper fertilization is good to control this disease and water-logged condition should be avoided. Soil should be drenched with carbendazim (0.2%). Soil should be sterilized before used. The diseased or infected plants or plant parts should be removed from the field or polyhouse.

Anthracnose

It is also a major disease of gerbera which caused by the fungus *Colletotrichum gloeosporoides*. In its infection reddish brown, circular spots, scattered which coalesce with one another in moist weather and cover large area that's why rolling, drying and weathering of leaves.

Management: Spray of fungicide bavistin (0.1%) is effective to control this disease. Excessive watering and overcrowding of plants should be avoided. The infected plant parts and debris should be burnt in time.

Blossom Blight

It is caused by the fungus *Botrytis cinerea.* The irregular shaped light brown coloured water soaked up area appears on the flower's stalks, which enlarge and coalesce producing depressed lesions. It affects to the entire flower.

The base of the stalk is girdled which cause drooping and death of plants. Poor drainage, poor ventilation and deep planting are the condition for the development of this disease and it should be avoided.

Management: Treatment with 0.2% thiram or 0.1% benlate helps to prevent the incidence of this disease. Infected plant parts and debris should be removed from the field.

Powdery Mildew

This is also a serious disease of gerbera which affect the growth of plant and quality of flowers. This disease is caused by the fungus *Erysiphae cichoracearum* and *Oidium ersiphoides f. sp. erysiphoides*. The white-coloured powdery mycelial growth is appeared on the plant parts. The disease or infected area get dried and fall.

Management: This disease can be controlled by spraying of fungicides like bavistin (0.1%), sulfex (0.3%) and kerathane (0.5%).

Bacterial Blight

This is a bacterial disease of gerbera. Small to large irregular or circular, brownish black spots with or without concentric rings appears on the leaves and plant parts.

Management: Use of streptocycline (0.01%) is found effective to control the incidence of this disease.

Leaf Spot

The disease is caused by *Alternaria gerbericola, A. alternata, A. tenis* and *A. dianthi*. This disease is distributed worldwide and is favoured by moderate temperature and high humid conditions. Circular to irregular, brown to black spots appears on leaves and petioles that coalesce to form bigger blotches.

Brown specks on ray florets are also noticed. Normally mature plants are more susceptible to this disease than younger plants.

Management: Low humidity should be maintained in the polyhouse or greenhouse. Overwatering or sprinkle system of irrigation should be avoided. Alternate spraying of fungicides like mancozeb (0.2%), propiconazole (0.05-0.1%) or chlorothlanil (0.2%) at 10-15 days interval found effective to control the incidence of leaf spot.

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Mushroom Spore Printing

Article ID: 35114

A. Karmel Reetha[1]
[1]Assistant Professor, Imayam Institute of Agriculture and Technology, Thuraiyur, Trichy, Tamil Nadu.

Introduction

The use of wild mushrooms for food in all probability began with the prehistoric man. During the long period human as a hunter gathered the fungi of the forest that has served as an important source of nourishment. There are many edible mushrooms. Describing the number of fungi on earth has been a position of conversation and several studies have focused on enumerating the world's fungal diversity (Crous *et al.,* 2006).

Although not technically accurate, mushroom spores can be thought of as "seeds", with each spore containing exactly half of the genetic information required to produce an actual mushroom. The spores are released into the environment from the gills (or pores) located under the cap of a mature mushroom. They then get carried away by air currents, and if they land in the right place, will eventually produce fine white strands of mycelium.

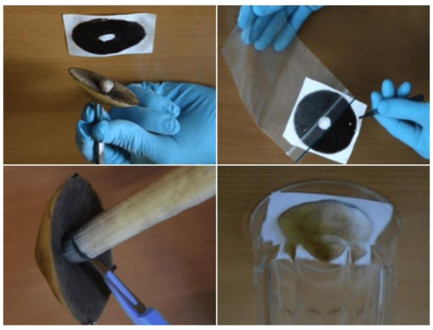
The mycelium will grow and eventually produce a new mushroom fruiting body, starting the cycle all over again. Spores come in all different shapes, colors and sizes depending on the species- they really are amazing! And to think that a single mushroom can release billions of spores into the air. That being said, the only factor visible to the human eye is the spore color, which is why taking a proper spore print is such an important characteristic for identifying mushrooms.

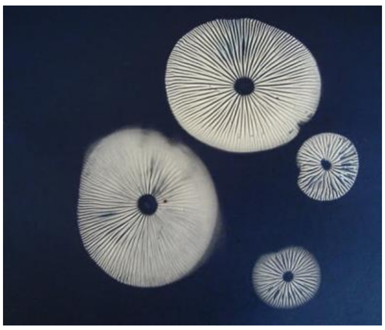
Materials Requirement

1. Mushroom Fruiting Body.
2. Printer Paper (white or black), tinfoil, or glass.
3. A drinking glass or a bowl to cover the mushroom cap.
4. A Ziploc bag for storing.

How to Make Spore Printing in Mushroom

Cut stem with sterile scalpel, at the highest possible point without touching gills. Place mushroom cap on a piece of paper for 12 to 24h, covered with a clean bowl. Remove mushroom cap. Pick up spore printed paper with clean tweezers and put in a ziplock bag. Can be stored at room temperature for years, in a dark and cool location.





Collecting Spores on Plates of Glass

Wash glass with soapy water, dry with wipe, clean with alcohol. Create a bind between both plates by joining the two plates with duct tape. Place mushroom caps on top of both plates for 12 to 24h, covered with bowl. Remove, dry and store mushrooms for later reference purposes. Seal the three remaining edges with more tape, creating a "Spore Booklet". Write bibliographic mushroom details. Can be stored at room temperature for years, in a dark and cool location. Glass allows for easy future use of spore as well as observation without risk of contamination.

Methods of Spore Printing

1. Scalpel and streaking:

a. Sterilize a scalpel by passing it through a flame, then cooling it in the "receiving" nutrified agar. This way the scalpel gets covered with a moist and adhesive layer of media for better spore attachment.

b. Touch the spore print with the scalpel tip to collect hundreds of spores.

c. Streak the tip into an "S" pattern across the surface of the petri dish.

d. 5 to 15 days later, your spores (should) germinate according to the streaking pattern.

e. Colonies of germinating spores can then be subculture into more petri dishes.

2. Paper rubbing:

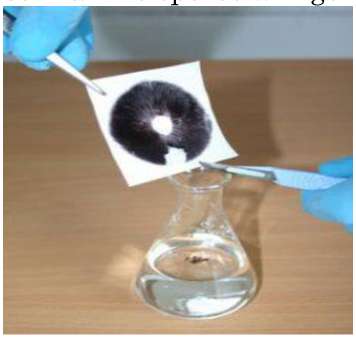
a. In this method, the spore print can be folded and rubbed together so that spores drop onto nutrified agar media

b. This method is not the best as concentrated populations of spores are grouped together.

3. Spore syringe:

a. Spore syringe is a bit trickier to make. It contains sterile water with hydrated spores in it.

b. The advantage of a spore syringe is that this spore water can be used to inoculate the substrate of your choice. This way the chance that the spores will germinate is much higher.



Microscopic Observation

For microscopic examination of spores, a thin deposit on a microscope slide is best. The print should be only just visible to the naked eye - an hour or two usually suffices. Naturally deposited spores tend to stick to the glass. If a drop of water and the coverslip are applied with reasonable care, the spores stay still when examined, even under oil immersion, which makes measuring easier. A spore print is always preferred for microscopy as all the spores are mature whereas gill preparations necessitate subjective selection of mature spores. If you are in doubt whether your fungus has dropped any spores at all, tilt the slide to catch the light. It may be useful to mark around the area with the spores using a glass-writing (or laundry) pen so you know where to put the coverslip. Spore prints in an herbarium allow future researchers to examine mature spores, so they need to be reasonably thick if possible. After air drying for half an hour, they should be protected ° against being rubbed off, e.g., wrapped in aluminum kitchen foil. it is good idea to label both the slides and foil Henrici (2004).

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Aerobic Rice Cultivation System: An Eco-friendly Approach for Rice Production

Article ID: 35115

Shashi Meena[1], Sheel Yadav[2]
[1]Division of Plant Physiology, ICAR-Indian Agricultural Research Institute, Pusa Campus, New Delhi-110012.
[2]National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi-110012.

Abstract
Millions of people depend on rice to maintain their livelihoods and for this reason, rice is called a staple food crop. Water is the most limiting natural resource becoming scared for agriculture purposes at present situation due to the failure of rains and over-exploitation of groundwater. The diminishing water resources reveal a grim situation for lowland puddled rice cultivation. Among the cereals, rice is a semi-aquatic crop and its cultivation is water and labor-intensive enterprise. It is estimated that about 4000-5000 liters of water are consumed for the production of 1kg rice. Farmers are seeking an alternative system of rice cultivation to combat this water-scarce situation. One such method is the cultivation of rice under the aerobic situation which is characterized by an aerated soil environment or with oxygen during the entire period of the growing season. Aerobic rice cultivation is a new way of growing rice that requires less water than low-land rice. It is grown like an upland crop such as ragi, maize, or jowar by giving surface irrigation, in soil that is not puddled, non-flooded or saturated. Aerobic rice system is an environment-friendly approach and the better remedy for future climate change under drought conditions with lesser greenhouse gas (GHG) emissions.

Introduction
Rice (*Oryza sativa* L.) is the most important staple food crop of the world and is a major energy source for about 60 percent of the world population. A large no. of people in Asia depended on rice for survival, hence, rice is life. It is necessary to increase the annual rice production to meet the demand of the ever-growing population. This has to be done despite the diminishing resources such as land and water that pose a real challenge for the scientific community. About 90 percent of the rice grown in the world is grown and consumed in Asia. Rice production in India is 121.46 million tonnes (Ministry of Agriculture and Framers Welfare, Third advance estimates of Principle crops (2020-2021)) in an area of approximately 44 million hectares. The projection of India's rice production target for 2025 AD is 140 million tonnes, which can be achieved by increasing rice production by over 2.0 million tonnes per year in the coming decade.

Traditionally rice production is synonymous with that of maximum water consumption as compared to other crops. Rice cultivation is a water-intensive system. It is estimated that about 60 percent of total available water in India is utilized for the cultivation of rice. To produce one kg of rice there is a need of 4000-5000 liters of water. Off late rainfall is erratic and water available for irrigation may not be efficient for sustainable rice cultivation. As we know that water is becoming scared the present situation for agriculture and is going to become a major issue in the future. Hence, it is essential to develop alternative rice cultivation practices that consume less water and have high water use efficiency.

Special Features of Aerobic Rice

The aerobic rice is a result of cross-breeding of local variety and IR64 procured from International Rice Research Institute Philippines. This technology package saves water, labor, fertilizers used for cultivation. Aerobic rice varieties have long roots, almost thrice the length of conventional rice variety, which help in better water absorption and facilitate better air circulation.

Normally, the greenhouse gas such as methane is produced during flooded rice cultivation by the anaerobic (without oxygen) decomposition of organic matter in the soil. It is recorded that paddy cultivation accounts for 20-25 percent of the methane gases emitted into the atmosphere.

Difference Between Aerobic Rice and Upland Rice

Upland rice is generally grown in rain-fed and naturally well-drained soils that are usually on sloping land with erosion problems, drought-prone, and poor physical and chemical properties.

a. Upland rice varieties are low-yielding but the drought- and low fertility-tolerant
b. Giving low but stable yields under the stress conditions of uplands.
c. Upland rice faces the problem of lodging and thus reduce yield.

Aerobic rice varieties are more input responsive and higher-yielding than conventional upland ones. It is mainly grown in flat land or terraced, and soil can be frequently brought to water field capacity by rainfall or supplemental irrigation, or where land is sloping but frequent rainfall can keep soils moist throughout the growing season.

'Aerobic Rice' Cultivation System

The aerobic rice cultivation system is the method of cultivation, where the rice crop is grown like an upland crop in soil that is not puddled, non-flooded or saturated. The way of planting aerobic rice is the same as we would do for the other cereal crops like wheat or maize by direct seeding. It is a sustainable rice production methodology and the most important promising approache for the immediate future to address the problem of water scarcity and environmental safety arising due to global warming. It is a renewed way of growing rice in non-submerged, non-puddled, non-flooded, or saturated soil by direct seeding like any other upland crop. Here, the soil is 'aerobic' or with oxygen throughout the crop growth, as compared to traditional flooded fields, which are 'anaerobic'.

In India, aerobic rice cultivation was conceptualized at UAS Bangalore by Shivashankar, G. and Shailaja Hittalmani (1980-1985). Two varieties for the aerobic situation were developed in 2007 (Aerobic rice brochure, UAS, 2011). It is reported that the yield of aerobic rice varieties ranges from 4.5 to 6.5 tonnes per hectare, which is about double that of traditional upland varieties and about 20-30 percent lower than that of lowland varieties grown under flooded conditions. However, the water used for aerobic rice cultivation was reported to be about 60 percent less than that of low-land rice.

Suitable Areas for Growing Aerobic Rice

The suitable area for aerobic rice cultivation includes:
1. Irrigated lowlands (where rainfall is insufficient to sustain rice production).
2. Delta regions (where there is a delay in water release from the reservoir).
3. Irrigated system of rice cultivation (where pumping from deep bore well has become so expensive).
4. Favorable Upland system (access to supplementary irrigation).

Accordingly, some of the states in India such as Tamil Nadu, Jharkhand, Chhattisgarh, parts of Bihar, Odisha, Karnataka, and eastern Uttar Pradesh are the projected area for aerobic rice cultivation because these areas have an uneven distribution of rainfall and frequently resulted in the occurrence of limited soil moisture.

Basic Principles of Aerobic Rice Cultivation System

'Aerobic rice' cultivation system is the sustainable agricultural methodology, which involves a set of practices for treatment of seed, plant, soil, weed, water, and management of nutrients. The basic practices of this cultivation system are:

1. Direct seeding of treated seeds.
2. It can be rain-fed or fully irrigated or supplementary irrigated.
3. Maintain water at just soil saturation level (aerobic i.e., with oxygen).
4. Puddling and submergence are not required.
5. Effective and timely weed control is crucial for the success of this system.
6. Row to row distance should be 20 or 25cm.
7. Use of efficient nutrient management practices along with integrated weed management for successful aerobic rice cultivation.

Advantages of Aerobic Rice Cultivation

1. Saves labor and water
2. Direct seeding
3. Saves seeds
4. Cost-effective
5. Eco-friendly
6. No need for puddle operation in the field
7. Anaerobic condition in soil
8. N-use efficiency is more
9. The cost of cultivation is significantly low
10. Efficient utilization of rainwater
11. Soil structure is maintained.
12. Improves soil health.
13. No need for Nursery preparation.
14. No need for transplanting.
15. Reduce methane emission.
16. Profuse Rooting.
17. High tillering.
18. High grain and fodder yield.

Disadvantages

1. Aerobic rice cultivation needs suitable rice varieties having the characteristics of both upland and high-yielding lowland varieties to get a good yield.
2. Increased weed growth, poor crop stand, the high percentage of sterility, and root-knot nematode infestation.
3. The high infiltration rate of water and imbalanced availability of nitrogen makes the aerobic soil further ailing for micronutrients (iron and zinc) and rise in nematode population.

Significance of Aerobic Rice System

In aerobic rice cultivation, rice is directly sown in non-puddle aerobic soil under supplementary irrigation and fertilizer with suitable high-yielding rice varieties. This cultivation system of rice is suitable for water-scarce environments. Aerobic rice is a water and labor-saving technology for water-shortage environments. As compared to the conventional system of rice cultivation, aerobic rice requires 30-50% less water. Additional irrigation is applied in the aerobic rice system as and when required and can be given in the same way as to any upland cereals crops like maize, wheat.

Aerobic Rice Cultivation System: Less emission of Methane (CH_4)

We know that methanogenesis is a process of emission of methane gas through the decomposition of organic matter by soil bacteria under anaerobic conditions. Methane is also produced from flooded paddy fields. It has been observed that some trials of aerobic rice cultivation were conducted at IRRI, showing approximately a 50 percent reduction in methane emission. So, we can make a conclusion that aerobic rice cultivation system is an eco-friendly approach and safe for the environment.

Cultural Practices for Aerobic Rice Cultivation

Aerobic rice cultivation is a renewed way of rice production.

1. Seedbed preparation: There is the requirement of minimum tillage for aerobic rice cultivation. Dry direct seeding ensures that the fields are well ploughed, leveled, and pulverized. Before doing ploughing operation, apply well-decomposed cow dung/FYM/compost @ 4-5t per acre. The field should be thoroughly prepared by using a disc plough, cultivator, and rotavator.

2. Seed rate and sowing method: Sowing can be done either by using manual seeding or drum seeder. The seed rate should be 40-45 kg/ha with a row-to-row distance is 20 or 25 cm. Line sowing should be preferred during the ideal moisture content of the soil.

3. Selection of Suitable Field for aerobic rice:

a. Select well-leveled fields having proper drainage facilities.
b. Avoid saline/alkaline soil for aerobic rice sowing.
c. Avoid inundated low-lying fields.

4. Varieties suitable for aerobic rice cultivation: In March 2007, India commercialized its first drought-tolerant aerobic rice varieties MAS 946-1 (2007) followed by MAS 26 (2008) at the University of Agricultural Sciences (UAS), GKVK, Bangalore, Karnataka. Hence, these two are the first varieties known for aerobic cultivation in the country. In India, National Rice Research Institute (NRRI), Cuttack, situated in Odisha, has developed six rice varieties suitable for aerobic cultivation system i.e., CR Dhan 200 (Pyari) (4.0 t/ha), CR Dhan 201 (3.8 t/ha), CR Dhan 202 (3.7 t/ha), CR Dhan 203 (Sachala) (4.0 t/ha) CR Dhan 205 (4.2 t/ha) and CR Dhan 206 (4.2 t/ha). These rice varieties perform well under this system and give a higher average yield as compared to upland high yielding varieties.

5. Irrigation water management: Aerobic rice system of cultivation can depend on rainfall or fully irrigated or supplementary irrigated. It can be also grown entirely on rainfall in the wet season with well-distributed rain. Water management is done to keep soil moist alternate wetting and drying. Maintain water at just soil saturation level by intermittent light irrigation coinciding with the appearance of hairline cracks or when seeing the visual condition (sign or symptoms) of the rice plant. Aerobic rice cultivation needs less water for irrigation as compared to transplanted rice.

According to critical physiological growth stages of rice crop, irrigation should be given at the following stages such as 1 DAS (or pre-sowing), tillering, panicle initiation (PI), flowering, and grain filling stages, respectively for obtaining high grain yield.

6. Weed management: As compared to the conventional method of rice cultivation (flooded condition), the weed population is very high in aerobic rice culture due to the non-flooded condition. Weed is a major problem for aerobic direct-seeded rice systems. Manual weeding is highly labor-intensive. Herbicides have been proven effective in many cases but intensive use may cause environmental contamination and the development of herbicide resistance. The use of weed-competitive varieties to suppress weeds might substantially reduce herbicide use and labor cost. Pre-emergence application of pendimethalin (PE) @1.0kgha-1 at 1-2 days after sowing should be done. Also applied 2, 4-D Na salt @ 0.80kgha-1 at 25-30 days after sowing. Two mechanical weedings or two hand weedings is done at 40 and 60 days after sowing (DAS). Pre-emergence application of pendimethalin + Rice: Dhaincha (1:1) + one (1) hand weeding or 2, 4-D Na salt application recorded lower weed biomass at 25 DAS of Rice under aerobic condition during Kharif season. At 55 DAS, with or without pre-emergence application of pendimethalin, 2 mechanical weedings controlled weed population and reduced weed biomass. It has been observed that weed biomass increases with higher nitrogen application at 55 DAS.

7. Nutrient management: Well-rotten and dried cow dung manure/F.Y.M/compost @5t/acre is applied at the time of final land preparation and mixed it with the soil thoroughly. Incorporation of green manure @3t/ha at 20 days before sowing. Zinc sulfate (ZnSo4) is applied @20-25kg/ha if Zn is deficient in the soil for proper soil health management. N, P_2O_5, K_2O @100-125, 60-40, 60-40 kg/ha is applied. Half dose of nitrogen, a full dose of phosphorus, 75% of potash, and a full dose of zinc (20-25kg ZnSo4/ha) as basal and remaining dose of N in two splits (25% N at active tillering and 25% N along with 25% potash at panicle initiation) are applied.

Variable Yields in Aerobic Rice System

It was observed that there was an incidence of variable yield and complete yield failure in the Philippines due to prevailing high atmospheric temperature during the flowering period, grain formation, and grain ripening stages. As a result of which, a large no. of grains in a panicle become chaffy and ultimately reduce the grain yield of aerobic rice. It was mainly due to the high-temperature stress during the reproductive period which results in spikelet sterility. Therefore, there is a need for good management practice for raising rice in the aerobic situation.

Another reason for aerobic rice yield reduction may be due to the soil-borne pathogens such as root-knot nematode (*Meloidogyne graminicola*), depletion of mineral nutrients, and accumulation of toxic substances in the soil.

Conclusion

The traditional method of rice cultivation is a water and labor-intensive method. Aerobic rice cultivation system needs suitable rice varieties having the characteristics of both upland and high yielding low-land varieties and also involves a mechanized way of sowing with no puddling, transplanting and does not require frequent irrigation. By 2025 water scarcity is predicted to be severe and management of the available water for various purposes will be a challenging situation. It is necessary to upgrade the existing farmers' practice of direct seeding of rice in the rain-fed situation with local varieties that fetched very low yields. Aerobic rice cultivation is a sustainable method of production of rice for the immediate future to address water scarcity and environmental safety arising due to global warming. Finally, we concluded that aerobic rice is the rice of the future.

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Tannery Pollution in Vellore District, Tamil Nadu

Article ID: 35116

R. Jayashree[1], R. Murugaragavan[1]
[1]Department of Soils and Environment, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai-625104.

Abstract
The earlier practice of vegetable tanning is prevalent from the days of the East India Company posed no hazards. But by the early 70s, it was replaced by modern chrome tanning which increased the number of chemicals used in the process from 42 to 276, including 13 heavy metals.

The state Environment Pollution Control Board has finally acted against 69 tanneries for discharging untreated effluent. The offending units, accused of discharging 12 million litres of untreated effluent daily, have been charged in the court of North Arcot's first class magistrate. The waste was dumped into the Palar River, which originates in Karnataka, flows through Tamil Nadu and then empties into the Bay of Bengal.

There are 302 registered tanneries in the Ambur, Vaniyambadi and Peranampet areas of the district. Besides, an estimated 2,000 drinking water wells in the taluk have turned repugnantly brackish (only 30 wells produce tolerably potable water). The poignance of the tragedy is all the greater because in drought hit in Tamil Nadu, Vaniyambadi was the rare taluk where clean drinking water was available at a depth of a mere 40 feet.

Keywords: Tannery effluent, Respiratory tract, Common Salt, Chromium.

Introduction
The Tamil Nadu state stands in the first place and in which the country having 53% of total leather units. In Vellore District which is the major hotspot of leather industry in Tamil Nadu and this district has been facing the impacts of tannery industries over the so many decades.

Around 70% of the Indian tanning capacity is in Tamil Nadu and about 40 % of the total exports from India is from Tamil Nadu with approximate earning cost of Rs.10,000 crore with 2.5 million employment and the major portion of leather products are manufactured only in the Vellore District of Tamil Nadu.

The major production centers of leather and leather productions in the state are Chennai, Ambur, Ranipet, Vanniyambadi, Perambur, Trichy and Dindigal. In Tamil Nadu more than 70% tanneries are located in Ranipet, Vanaiyambadi, Dindigul, Ambur.

Impact of Tannery Pollution in Vellore District
The tanning industries in Ambur, Vaniyampadi, Pernampet and Ranipet of the Vellore District led to environmental threat and respiratory problems to those who are working. The primary environmental threat involves in the dumping of solid and liquid waste that contains leftover chromium and other hazardous compounds. Around 40 per cent of tannery workers in this district have health problems because they are in direct contact with the chemicals from the industries.

1. This industry is one of the major consumers of fresh water and most of the water is discharged as wastewater. The quantity of total wastewater discharged for 100 kg of skins and hides processed varies from 3000 to 3200 liters. Common salt is the biggest polluting material in the tanning industry. The amount of wastewater generated by the tanneries is approximately from 2.5 to 3.0 million liters per day, which in turn collected in irrigation lakes. Then the pollution penetrated vertically and makes it unfit for drinking, irrigation and for general consumption. According to a report, a sole tannery is capable of causing the pollution of groundwater in a scope of about 7 to 8 km in radius.

2. The peoples were working in the tannery industries are exposed to the changing atmosphere and the worst polluted sites, modern tanning process involves the handling of chromium, which causes a multitude of ailments depending on how it is absorbed. If it coalesces with the respiratory systems of our body, it acts

as a lung irritant and carcinogen, affecting the upper respiratory tract, obstructing airways, and increasing the chances of developing lung, nasal, or sinus cancer. Chromium normally is absorbed this way as fine particulate dust that is produced when both raw and tanned leathers are buffed, smoothed, and ground up.

3. The tannery pollutants increased the rates of asthma, bronchitis, polyps of the upper respiratory tract, pharyngitis, and the enlargement of the hilar region and lymph nodes.

4. Groundwater contamination is prevalent in Vellore District due to the excessive number of tannery industries in the district. It has become another major threat to the human community in the district. The process being undertaken by the tannery industries leads for huge consumption of water along with dangerous chemicals like lime, sodium carbonate, sodium bi-carbonate, common salt, sodium sulphate, chrome sulphate, fats, oils, dyes etc.,

5. Contaminations of the groundwater lead to availability of unhealthy drinking water, limited quantity of water availability, land and other health issues. The major water resources for Vellore District are the river Palar and it was entirely polluted by 426 numbers of tanneries in and around the Vellore Districts.

6. The water in and around Ranipet industrial area is significantly contaminated. This indicates those groundwaters are significantly degraded and suffer from extensive salinization. It may cause laxative effects on health of the people consuming that water and it is not suitable for domestic purpose.

7. The waste water discharged from the industries were partially treated by conventional method and let out to Palar River which results in ground water pollution. There is no flow in the Palar River due to the failure of monsoon for the past fifteen years and the construction of reservoirs in the upstream of the river. The ground water table decreased due to the continuous withdrawal of water for the agricultural, industrial and domestic uses. Further the continuous discharge of effluent leads to the increase of dissolved solids in the ground water and drastic increase of dissolved solids emerged the need of advanced wastewater treatment.

8. In most of the tanneries, sedimentation tanks are used to remove the suspended solids. The chromium is removed along with the sludge. The sludge is dried over sand and there is no appreciable reduction of dissolved solids, BOD, COD, colour and chloride can be achieved in this treatment process. In the biological treatment chemical coagulation is used. Several coagulants like Alum, Ferric chloride, and Ferrous sulphate have been used. Ferrous sulphate is said to be the best coagulate for the effective removal of colour, chromium, sulfides, BOD and suspended solids from chrome tan wastes.

Control Measures

1. The control measures for tannery waste management are a difficult task to manage, due to the highly toxic pollution load in tannery wastes and especially it contains carcinogenic heavy metal chromium and it is being magnified in the air, soil and water ecosystem. However, lot of technologies can be used to alleviate the toxicity of tannery wastes contaminated in the ecosystem.

2. Heavy metals can be removed from wastewater using biological processes mainly by adsorption and metal complexation with microorganisms. Potentially treat the tannery effluents by anaerobic digestion, aerobic bacterial, macrophyte and algal systems. Chemical treatment options such as precipitation, carbon adsorption, ion exchange and reverse osmosis, etc., can be implemented to manage the tannery wastes.

3. Conventional solid waste management options such as waste minimisation at source, recycling and reuse, transformation and properly designed and maintained sanitary landfills, can be used to tackle the problems associated with tannery solid wastes.

4. Environmental regulations concerning effluent discharge limits have to be enforced to ensure compliance by those tanneries disposing of solid wastes and discharging untreated effluents into watercourses. Agencies should take care to treat the waste water from the industries by using effluent treatment plant and it should be periodically monitored for safeguarding the public and ecosystem.

Conclusion

The organic and inorganic chemical pollutants from the conventional leather process are highly toxic and discharged through the effluent which causes serious problems to air, soil and water ecosystem. To conserve the ecosystem by utilizing advanced technologies viz., green chemistry and green technology. The advanced treatment technologies like Reverse osmosis can be put forth for treating the wastewater from the tanneries and it can be used for industries to say Zero Discharge Level.

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Recent Advances in Host Defense Against Viruses and Bacteria

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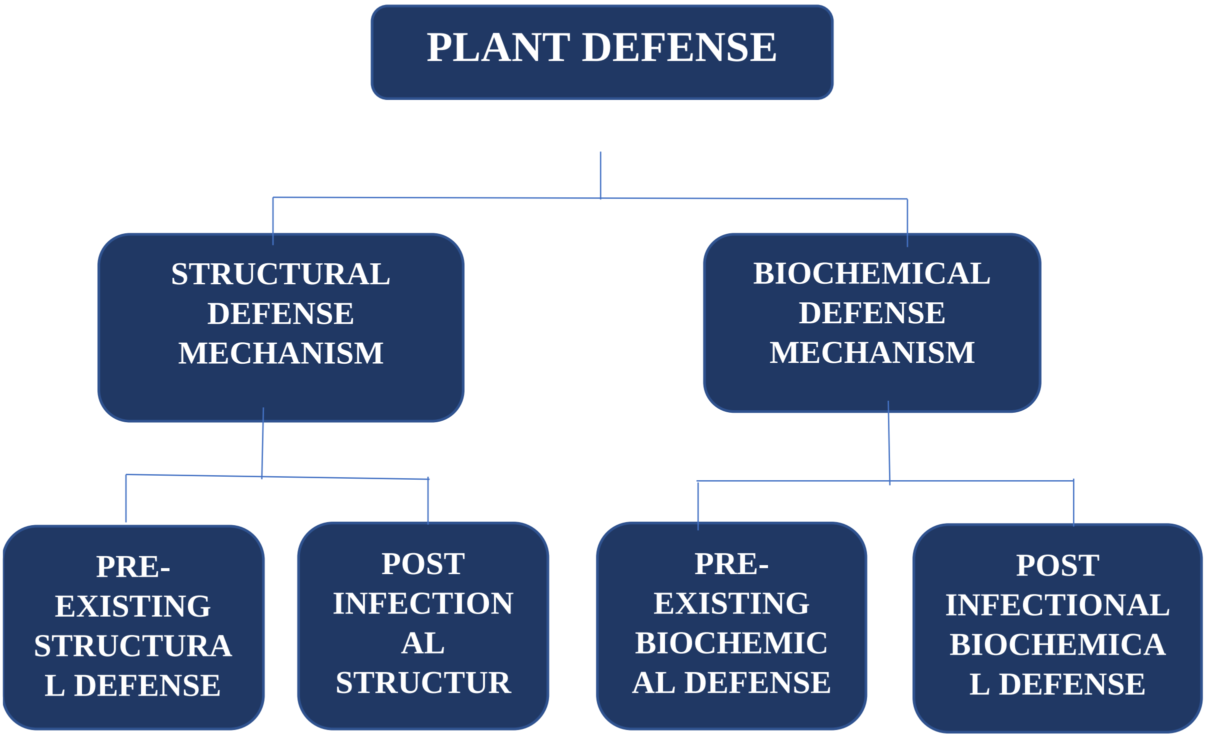
Katravath Srinivas[1], Shaik Moizur Rahman[1]
[1]College of Agriculture, Rajendranagar, PJTSAU, Hyderabad, 500030, India.

Introduction

Plants signify a rich source of nutrients for many organisms including fungi, bacteria, virus, insects, nematodes and vertebrates. Plant deficient in an immune system comparable to that of animals. Plants have developed a striking array of structural, chemical, and protein-based defences designed to detect invading organisms and stop further them before they are able to cause widespread damage. Each plant species is affected by approximately hundred different kinds of fungi, bacteria, viruses, mollicutes and nematodes.

Basically, Plant Defence is Classified as Follow



Pattern-Triggered Immunity and Effector Triggered Immunity

The Innate Immunity of Plants against pathogen famously called as Zig-Zag model of plant microbe interaction this model was proposed by Jeff Dangl. In phase 1, plants detect microbial or pathogen-associated molecular patterns (MAMPs or PAMPs) via pattern recognition receptors (PRRs) to trigger PAMP-triggered immunity (PTI).

In the phase 2, successful virulent pathogens transport and deliver effectors molecules that interfere with PTI, or otherwise enable pathogen nutrition and dispersal, which results in effector-triggered susceptibility (ETS). In phase 3, effector is recognized by an R- protein, activating effector-triggered immunity (ETI), an augmented version of PTI that often passes a threshold for induction of hypersensitive response (HR). In the final phase 4, pathogen isolates are selected that have missing the old effector, and possibly gained new effectors through horizontal gene flow these can help pathogens to suppress ETI.

Mitogen-Activated Protein Kinase (MAPK)

Plant mitogen-activated protein kinase cataracts in regulating plant defense hormone biosynthesis and signaling. Pathogen-responsive Plant mitogen-activated protein kinases are involved in the induction of biosynthesis of plant hormones, including ethylene, salicylic acid (SA), jasmonic acid (JA), and nitric oxide (NO), which are secondary signaling molecules of plant d efense responses. MAPKs are also implicated in salicylic acid (SA) and jasmonic acid (JA) plant signaling pathways.

Canonical Plant R Proteins have a Nucleotide Binding Site and LRR

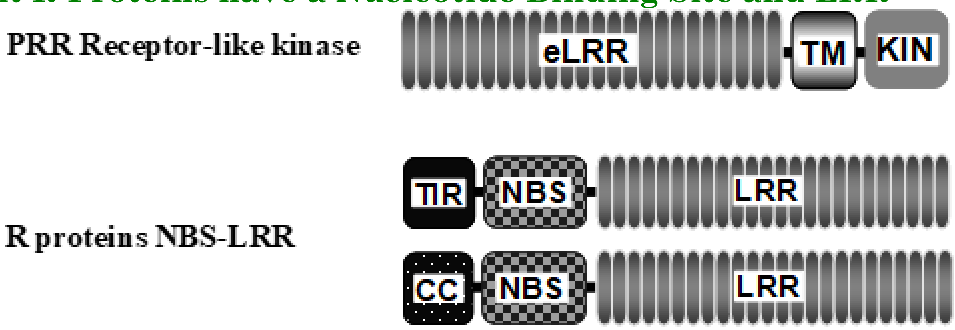


Fig. 1 Canonical plant R proteins

Hypersensitive Response (HR)

Hypersensitive response (HR) is described as a form of programmed cell death (PCD) at the site of pathogen infection, which is believed to be quarantine biotrophic pathogens at the site of pathogen entry and consequently prevent spreading outward towards healthy tissue (Heath, 1998).

Well characterized plant resistant genes against virus and corresponding Avr determinant of virus. Table. 1:

Gene	Plant	R protein Structure	Virus	Avr determinant
N gene	Nicotiana sp.	TIR-NB-ARC-LRR	Tobacco mosaic virus	Replicase
Rx1 gene	Solanum tuberosum	CC-NB-ARC-LRR	Potato virus X	Coat protein

Ubiquitin Proteasome System: A Dual Role

Ubiquitin Proteasome System (UPS) regulates cellular activities including transcription, cell cycle and signal transduction. Plants uses this mechanism to defend counter to virus infections, but viruses use the Ubiquitin Proteasome System to promote virulence. Movement proteins of Tobacco mosaic virus and Turnip yellow mosaic virus are also specifically targeted for degradation by the host Ubiquitin Proteasome System machinery, resulting in reduced virulence and pathogenicity.

Recessive Gene–Mediated Responses to Virus Infection

It is of two types first one is loss of the function in the host proteins crucial for the establishment of disease. Second host proteins which regulates virus replication and movement.

Loss of Function in Host Proteins Critical for the Establishment of Disease

Amino acid mutations in the eukaryotic translation initiation factor, eIF4E, mediates resistance against several viruses in Arabidopsis, tomato, pepper, pea, melon, and barley. Mutations in another subunit of eukaryotic translation initiation factor, eIF4G, imparts recessive resistance against Rice yellow mottle virus (RYMV) in rice (*Oryza sativa*) and to CMV and TCV in Arabidopsis.

Host Proteins Which Regulate Virus Replication and Movement

Lectin-mediated resistance: Lectin proteins are novel and intriguing resistance imparting proteins. An Arabidopsis jacalin-type lectin, RESTRICTED TEV MOVEMENT1 (RTM1), that mediates resistance against Tobacco etch virus (TEV). RTM1 inhibits systemic movement of TEV through interference with viral movement–associated proteins.

How it is Different from R Gene Mediated Response?

Lectin-mediated resistance (LMR) does not invoke HR and SAR responses, nor does it alter SA levels, signalling, or other typical defense gene expression changes commonly modulated in immune resistance responses.

Novel Proteins in Plant Defence

Magainins: Magainin is a defense peptide and it is secreted from the skin of the African clawed frog (*Xenopus laevis*). It was first discovered by Zasloff (1987). Li *et al*., (2001) have testified disease resistance, to both fungal and bacterial pathogen, conversed by expression of a magainin analogue, Myp30, in transgenic tobacco (*Nicotiana tabacum* var. Petit Havana). Additional analogue MSI-99, when expressed in tobacco via., chloroplast transformation contributed both in vitro and in plant resistance to pathogenic bacteria and fungi (De Gray *et al*., 2001).

Cecropins: Cecropins are antibacterial lytic peptides innate to the haemolymph of *Hyalophora cecropia*, the giant silk moth. Cecropin peptides interact with the outer phospholipid membranes of both Gram-negative and Gram-positive bacteria and change them by forming a large number of transient ion channels (Durell et al., 1992).

Native (Cecropin B), mutant (SB37, MB39) and synthetic (Shiva-1, D4E1) cecropins are active in vitro against an extensive range of plant pathogenic bacteria which includes *Erwinia carotovora*, *Pseudomonas syringae*, E. *amylovora*, *Ralstonia solanacearum* and *Xanthomonas campestris* however they employ no toxicity at bactericidal concentration to cultured cells or protoplasts of several plant species (Kaduno-Okuda *et al*., 1995; Rajasekaran *et al*., 2001).

Attacins: Attacins are additional group of antibacterial proteins produced by *Hyalophora cecropia* pupae (Hultmark *et al*., 1983). The mechanisms of antibacterial activity of attacins protein are to hinder the synthesis of the outer membrane protein in gram negative bacteria (Carlsson *et al*., 1998).

Attacin expressed in transgenic potato boosted its resistance to bacterial infection by *E. carotovora subsp. atrospetica* (Arce *et al*., 1999). Transgenic pear and apple expressing attacin genes have suggestively heightened resistance to *E. amylovora* in *in vitro* and greenhouse (Norelli *et al*., 1994), (Ko *et al*., 2000).

Lysozymes: Lysozymes are an omnipresent family of enzymes that happen in many tissues and secretions of humans, animals, as well as in plants, bacteria and phage. The lysozyme effects the Murein layer of bacterial peptidoglycan ensuing in cell wall weakening and ultimately leading to lysis of both Gram -negative and Gram-positive bacteria. Hen egg-white lysozyme (HEWL), T4 lysozyme (T4L), T7 lysozyme (Huang *et al*., 1994), human and bovine lysozyme genes have been cloned and transferred to augment plant bacterial or fungal resistance.

Plantibodies: The expression of virus-related or nematode-specific antibodies in plants henceforth, the term plantibody, (Gibbs 1997, Smith 1996) is a hopeful new avenue for controlling plant pathogens (Schots *et al*. 1992). It was testified in the case of Tomato Spotted Wilt Virus (TSWV) (Franconi *et al*. 1999) and Root-knot nematodes *Meloidogyne spp*. (Baum *et al*. 1996).

Genetic Engineering

Plant Transgenics: Plants encompassing transgenes are known as transgenic plants or genetically modified Plants.

Important examples in plants. Table 2:

Transgene	Source	Target species	Pathogen	Reference
Coat Protein gene	Papaya ringspot virus (PRSV)	Carica papaya	PRSV	(Fuchs and Gonsalves, 2007)
C1	Tomato Yellow Leaf Curl Virus (TYLCV)	Lycopersicon esculentum	TYLCV	(Fuentes et al., 2006)
NPR1	Arabidopsis thaliana	Arabidopsis thaliana	Pseudomonas syringae	Cao, Li and D

Pto	Lycopersicon pimpinellifolium	Lycopersicon ecsulentum	Pseudomonas syringae pv tomato	(Tang et al., 1999)

Pathogen-Derived Resistance

A portion, or a complete viral gene is introduced into the plant, which, afterward, interferes with one or more vital steps in the life cycle of the virus. Pathogen-derived resistance was first exemplified in tobacco by Roger Beachy and co-workers. Introduced the viral coat protein (CP) of tobacco mosaic virus (TMV) into tobacco and observed tobacco mosaic virus resistance in the transgenic plants.

Coat Protein

Transgenic papaya (var. sunrise and Rainbow) with CP gene was grown from 1991 to 1993, and endured virus- free for 25 months in Hawaii.

Table. 3:

Feature	Coat protein gene	Satellite RNA	Defective viral genome	Antisense viral genome	Ribozyme
Mode of action	Interferes with uncoating virus spread	Interferes with virus replication, symptom development	Interferes with replication of virus	Binding to RNA prevents function	Clevage of RNA genome / mRNA
General Applicability	Yes	NO	NO	Yes	yes
Effectiveness against unrelated viruses	Some effect on systemic spread	None	None	Possibly if conserved sequences in the viral genomes can be	
Required level of expression by host plants	Possibly High	Low	Possibly High	Possibly High	Possibly High
Efficacy	High in many cases	High	Medium	low	Probably high

RNA Interference (RNAi) Pathways in Plants

Small-interfering RNAs are known as siRNAs can be generated from double-stranded RNAs (dsRNAs) derived from viral replication and or gene expression of RNA and DNA viruses, dsRNAs synthesized by plant endogenous RNA-dependent RNA polymerases, and single-stranded RNAs that form extensive secondary structures in plant cells. Dicer-like proteins process the dsRNAs and/or dsRNA-like molecules into siRNA duplexes (shown as blue small dsRNAs). siRNA duplexes are loaded into Argonaute protein (AGO) in the RNA-induced silencing complex (RISC), where one strand is selected to be the guide strand for silencing. The targeted RNAs are then degraded.

Table. 4:

Target organism	Disease	RNAi	Target sequence	Experimental plants
Agrobacterium tumefaciens	Crown gall	Transgenic plants	IaaM and ipt oncogene mRNAs	*Arabidopsis thaliana*
Xanthomonas citri subsp. citri	Citrus canker	CRISPER genome editing	CsLOB1 promoter	*Citrus sinensis Osbeck*
Turnip Yellow Mosaic Virus	Turnip yellow mosaic and Turnip mosaic	Transgenic plant	Cm-Eif4e mRNA	*Cucumis melo* (muskmelon)

Tomato Yellow Leaf Curl Virus	Tomato yellow leaf curl	Transgenic plant	C1 (Rep) coding sequence	*Solanum lycopersicum* (sour cherry)

Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)

Clustered regularly interspaced short palindromic repeats is known as CRISPR-Cas9. It is a genome editing tool that is producing a buzz in the science world. It is quicker, cheaper and further accurate than earlier techniques of editing DNA and has an extensive range of potential applications.

Case Study Related to Viral Defence

Agrobacterium comprising the engineered T-DNA vector. Targeting the tomato yellow leaf curl virus genome with Cas9-single guide RNA at the sequences encoding the coat protein or may be with replicase resulted in effective virus interference, as shown by low accumulation of the tomato yellow leaf curl virus DNA genome in the transgenic plants.

Conclusion

In a natural ecosystem due to co-evolution of plants and pathogens, plant was having a wide array defense mechanisms to pathogens, but pathogens were always evolving and breaking the resistance barrier. Development in modern technology provided a strength to a potential and healthy plant.

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Seasonality in Insects

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Mr. Manoj Kumar Jena[1], Mr. Kanhaiya Lal Bairwa[1]
[1]P.G. Research Scholar, Department of Entomology, Navsari Agriculture University, Navsari, Gujarat.

Introduction

Seasonality is an important and relatively well studied aspect of insect biology. Even in localities with little seasonal climatic variation, seasonal fluctuation of arthropods has been reported. A phenomenon is seasonal if it or its maximum expression, predictably occurs at roughly the same time of the year, each year that it does occur. The phenology of a phenomenon is the temporal distribution of that phenomenon. The seasonality of a phenomenon is the phenology of that phenomenon and the degree to which it is seasonal. Season refers entirely to the phenomenon under discussion as in mating season and growth season, and has no a priori connection with the conventional seasons such as "summer" or "dry season."

Classification of Seasonality

There are various kinds of seasonality in insects:
1. Diapause
2. Quiscence
3. Aestivation
4. Hibernation etc.

Diapause

Diapause is an important adaptation in many insect species enabling them to sustain in regions which would otherwise be unfavourable for permanent habitation and to maintain high numbers in an environment which might otherwise support only a low population. The term “diapause” was applied by Wheeler to egg stage of grasshopper, *Conocephalus ensiferum* at which its development was ceased. Diapause is the periods of arrest in ontogenetic (origin and development of organisms) development” by Henneguy.

Diapause process is a splendid chance for insects to survive a great deal of seasonal changes in the environment. Diapause is not a physiological process; rather it is brought about by token stimuli that presage a change in the environment. It is highly important in temperate zone insects that overwinter. Most of the insects enter diapause at a single species-specific stage in their life cycle. Usually, diapause occurs in that stage of the life cycle which is highly adapted to resist the hardness of the climate.

Classification of Diapause

According to life stages:

a. Egg diapause: Egg stage undergoes diapause. e.g.-*Bombyx mori*; *Lymantria dispar*; Grasshopper; Locust.

b. Larval diapause: Larvae stage undergoes diapause e.g.- Euproctis sp., *Pectinophora gossypiella*;

c. Pre-pupal diapause: Pre-pupa stage undergoes diapause. e.g.-*Plodia interpunctella*;

d. Pupal diapause: Pupa stage undergoes diapause. e.g.-Red hairy Caterpillar *(Amsacta albistriga)*; *Manduca sexta; Pieris brassica*.

e. Adult diapause: Adult stage undergoes diapause e.g.-Mango nut weevil *(Sternochaetus mangiferae)*; White grub; *Danaus plexippus*; Epilachna; *Leptinotersa decemlineata*.

f. Imaginal diapause- Stage that undergoes diapause is not specific. e.g.-Mosquitoes; According to to the influence of environmental factors.

According to the influence of environmental factors:

a. Obligatory diapause: It refers to the stage of suspended activity of the insect which is a hereditary character controlled by genes and is species specific e.g., egg diapause in silkworm.

b. Facultative diapause: It is the stage of suspended activity of the insect due to unfavourable conditions and with the onset of favourable condition, the insect regains its original activity. e.g., Cotton pink bollworm *Pectinophora gossypiella*.

According to seasonal variations:

a. Aestivation (summer diapause): The period of suspended activity in individuals occurring due to seasonal high temperature is known as aestivation.

b. Hibernation (winter diapause): The period of suspended activity in individuals occurring due to seasonal low temperature is known as aestivation.

According to physiological and ecological mechanisms of its incidence and termination:

a. Parapause: An obligatory hereditary arrest of development or arising in every generation at a species-specific instar.

b. Oligopause: An arrest of development or activity with control of its induction, maintenance and termination similar for all these periods.

c. Eudiapause: A facultative arrest of development or activity with different controlling mechanisms of induction and termination, e.g., through photoperiod and chilling, respectively.

Incidence of Diapause

Diapause may occur in any stage of the life cycle of insects, such as eggs, larvae, pupae or adult. The stage at which diapause occurs is highly characteristics for each species. Moreover, there is no case known in which diapause occurs in more than one stage of same life cycle. At the egg stage, it may begin; when the embryo is still very young (e.g., *Gryllulus Austroicetes*); when embryo is half-grown (e.g., Differential grasshopper, *Melanoplus diflerenti*; when embryo is fully grown and apparently ready to hatch (e.g., red-legged grasshopper tent caterpillar).

Intensity of Diapause

Diapause is also immensely variable in its duration. The duration of diapause can be taken as a measure of intensity. Diapause lasts for 9-10 months in temperate zones, and may persist for a year or less common cases. During diapause, most insects do not feed at all or, in the case of some larvae and adults feed very little. This indicates that the insects must sequester sufficient food reserves in the pre-diapause phase to meet its metabolic needs during diapause still have sufficient reserves remaining at the diapause to complete development and resume the growth. Diapause lasting more than a year is known as prolonged or extended diapause, and has been documented in 64 insect species. For example, moth *(Prodoxus inversus)* adults emerge a year of diapause as prepupae. In some sawflies, diapause stage lasts for 3-4 years. Extra-long diapause may be achieved either by entering diapause exceptionally early (premature diapause) or by completing diapause exceptionally late (prolonged diapause). In both the cases, induction of diapause may be density-dependent or density-independent.

Phases / Stages of Diapause

1. Pre-diapause Phase:

a. Induction Phase: Induction phase occurs during genotype specific ontogenetic stage(s) (sensitive period) when cues from the environment are perceived and transduced into switching the ontogenetic pathway from direct development to diapause when the token stimuli reach some critical level (the response may be modified by other environmental factors).

b. Preparation Phase: Preparation phase occurs where the phases of diapause induction and initiation are separated by a period of direct development, during which the individual is covertly programmed for later expression of diapause. Behavioural and physiological preparations for diapause may take place. Changes taking place during this phase are food storage, behavioural changes and some changes in rate of development.

2. Diapause Phase:

a. Initiation Phase: Direct development (morphogenesis) ceases, which is usually followed by regulated metabolic suppression. Mobile diapause stages may continue accepting food, building of energy reserves and seeking suitable microhabitat. Physiological preparations for the period of adversity may take place and intensity of diapause may increase.

b. Maintenance Phase: Endogenous developmental arrest persists while the environmental conditions are favourable for direct development. Specific token stimuli may help to maintain diapause (prevent its termination). Metabolic rate is relatively low and constant. Unknown physiological process leads to more or less gradual decrease of diapause intensity and increase of sensitivity to diapause terminating conditions.

c. Termination Phase: Specific changes in environmental conditions stimulate (accelerate or resume) the decrease of diapause intensity to its minimum level and thus synchronize individuals within a population. By the end of the termination phase, a physiological state is reached, in which direct development may overtly resume (if the conditions are favourable) or covert potentiality for direct development is restored but not realized (if the conditions are not favourable).

3. Post-diapause Phase: During Post-diapause quiescence, inhibition of development and metabolism was exogenously imposed, which follows the termination of diapause when conditions are not favourable for resumption of direct development. It implies reorganization prior to full activity. Insect diapause is centrally mediated at specific developmental stages, either in response to key stimuli from environment (facultative diapause) or as a fixed component of ontogeny (origin and development of an individual organism from embryo to adult) (obligatory diapause). The maintenance of diapause itself is a physiologically dynamic and it changes over time in response to internal stimuli and environment.

Diapause vs. Quiescence

Dormancy is a generic term for any state of naturally occurring ecological or evolutionary adaptations of arrested development, and usually accompanied with metabolic suppression. Diapause and quiescence form two different types of dormancies in insects. In general, insects commonly confront two types of major environmental stresses. The second category of stress includes regularly occurring, seasonal fluctuations in temperature, humidity, food, natural enemies and other competitors over a wide geographic area. This stress is kind of predictable pressure occurring in some specific pattern and insects take advantages of this predictability by responding physiological and behavioural alterations forthcoming changes. These types of stresses constitute diapause. Diapause is quite distinct from quiescence but at times it may be difficult to distinguish the phenomena. Quiescence is common seasonal (phenological), long duration adaptation in life cycles of many insects. Unlike diapause, quiescence is directly induced and terminated by surrounding environmental conditions.

Theories of Diapause

1. Many theories are out there to explain the process of diapause.
2. Hormone theory of diapause.
3. Ecological consequences of hormone theory.
4. The stimulus which activates the neuro-secretory cells in species without diapause.
5. Evidence from ecology for the “food mobilization” hypothesis.
6. The food mobilization hypothesis.

Aestivation (Summer Sleep or Summer Dormancy)

The period of suspended activity in individuals occurring due to seasonal high temperature is known as aestivation. The word derives from the Latin for summer (aestas) or heat (aestus). Arid conditions that restrict water and food availability are the common trigger for aestivation, often but not always accompanied by hot summer temperatures. Aestivation is an ancient trait. Some animals have ability to remain dormant during unfavourable summer months when there is water scarcity or intense heat. Aestivation is shown by desert animals and variety of them like snails, ground squirrel etc. some show aestivation & hibernation. e.g., Snails show hibernation / aestivation according to availability of water. Normally in insects, during summer the adults die but the eggs & pupae survive by remaining dormant. In case of snails, saw bugs, shrimps’ adults remain dormant in unfavourable condition.

Hibernation (Winter Sleep or Winter Dormancy)

The period of suspended activity in individuals occurring due to seasonal low temperature is known as Hibernation. It is a physiological mechanism used by heterothermic animals to conserve energy. It is a process classically categorized by lowering one’s metabolic rate or heart rate, reducing body temperature, and regulating oxygen consumption. The intensity of these processes varies between taxa and can fluctuate from daily to multiday torpor (hibernation). Endotherms have high energy requirements and maintain their core body temperature (Tb) by means of heat production. Maintaining Tb in itself is energetically costly but is required for proper cell function, reproduction, and behavioural efficiency (Geiser 2013; Martin 2001). Endothermic animals regularly exhibit what is called hypometabolism during periods of inactivity, where an individual lowers their normal metabolic rate by an average of 20% and most often in conjunction with lowering Tb by 2 degrees Centigrade (Heldmaier et al. 2004).

Conclusion

Seasonal variations occurring in different regions may be favourable or unfavourable for the survival of insects. When the periods are unfavourable for the survival of insects, the insects adopt various strategies to overcome the unfavourable condition and when the favourable conditions come, they further resume the development. This phenomenon is defined by many scientists in their own different ways; however, the main idea remains the same. Diapause occurs at different life stages of insects, such as embryo, egg, larvae, pupae and adults. It is quite distinct from "quiescence", but sometimes it may be difficult to discriminate between the two phenomena. Various factors, including temperature, photoperiod, moisture, food and geographic location control the process of diapause. Different processes, such as dormancy, migration and polyphenism can be modified by diapause. Diapause termination can happen by means of chemicals, hormones, oxygen level, chromosome numbers, wounding and genetics. Aestivation and hibernation are the two stages of diapause and are survival strategies used by many vertebrates and invertebrates to endure arid environmental condition. Key features of aestivation include strong metabolic rate suppression, strategies to retain body water, conservation of energy and body fuel reserves, altered nitrogen metabolism, and mechanisms to preserve and stabilize organs, cells and macromolecules over many weeks or months of dormancy.

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Bio-Fertilizers and Soil Fertility

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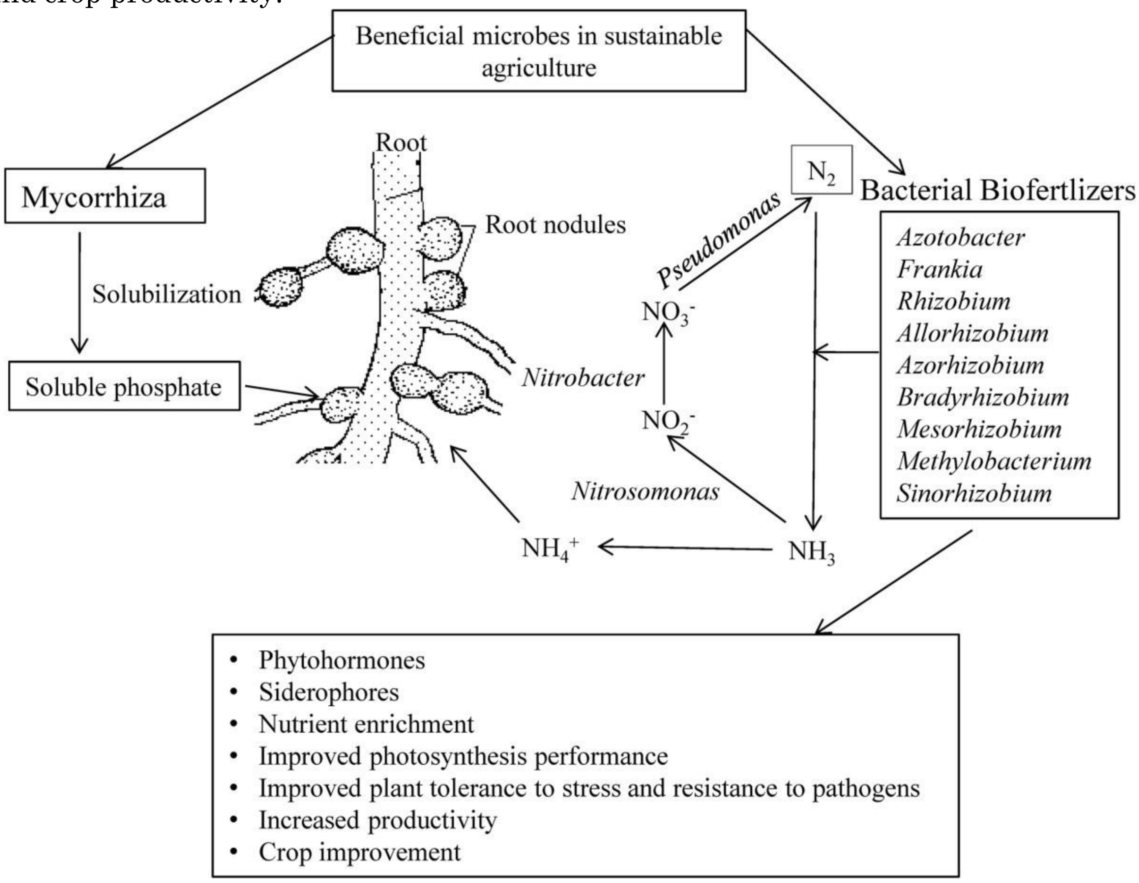
Sabarinathan K. G[1], Gomathy M[1], D. Rajkumar[1]
[1]Agricultural College and Research Institute, Killikulam, Vallanadu, Tuticorin District, Tamil Nadu Agricultural University, Tamil Nadu.

Abstract
Biofertilizers composed of free-living bacteria promote plant's growth, improve productivity through the strengthening of its roots, and reduce the amount of synthetic fertilizer applied to the crops. Farmers can reduce the application of synthetic fertilizers and sustainably increase crop yield through the use of this biofertilizers. Biofertilizers are made in laboratory with live or latent cells of organisms, either nitrogen fixers, solubilizers of phosphates, cellulites microorganisms, growth promoters, among others, which are applied to seeds or plants in order to boost their growth.

Introduction
Biofertilizers keep the soil environment rich in all kinds of micro- and macro-nutrients via nitrogen fixation, phosphate and potassium solubilisation or mineralization, release of plant growth regulating substances, production of antibiotics and biodegradation of organic matter in the soil.

Biofertilizers are applied as seed or soil inoculants, they multiply and participate in nutrient cycling and benefit crop productivity, whose interactions also determine crop health in natural agro-ecosystem by providing numerous services to crop plants *viz.,* organic matter decomposition, nutrient acquisition, water absorption, nutrient recycling.

Figure 1
From: Biofertilizers function as key player in sustainable agriculture by improving soil fertility, plant tolerance and crop productivity:



Natural "N" Fixation

Nitrogen is among the top 3 vital nutrients for crop development, being responsible for the process of photosynthesis and chlorophyll contents. Nitrogen fixation in soil is important for agriculture because even though dry atmospheric air is 78% nitrogen, it is not the nitrogen that plants can consume right away. However, fertilization is not the only solution – biological nitrogen fixation is a more economic, ecological, and even profitable option. It is possible thanks to nitrogen-fixing organisms and crops.

Intensive agriculture relies on important application of N fertilizers, along with other essential nutrients for maximizing crop productivity. On the other hand, up to 50% of the application of conventional N-based fertilizers is subject to loss into the soil and the environment (Singh et al., 2014, 2015a). This could substantially inflict economic and environmental issues such as increasing greenhouse gas emissions (e.g., nitrous oxides volatilization accounts for approximately 10-fold emission of CO_2-equivalent), soil acidification, depletion of non-renewable resources and nitrate leaching into the groundwater and surface water, which can cause devastating effects such as water eutrophication. Thus, there is a need to sustain use of N fertilizers in order to meet agriculture sustainability challenges consisting of a better crop nutrition and productivity needed for the ever-increasing world population.

Natural "P" Fixation

Phosphorus (P) is one of the major growth-limiting macronutrients required for proper plant growth, particularly in tropical areas, due to its low availability in the soil. It accounts for between 0.2 and 0.8% of the dry weight of plants, and it is contained within nucleic acids, enzymes, coenzymes, nucleotides, and phospholipids. P is essential in every aspect of plant growth and development, from the molecular level to many physiological and biochemical plant activities including photosynthesis, development of roots, strengthening the stalks and stems, formation of flowers and seeds, crop maturity and quality of crop, energy production, storage and transfer reactions, root growth, cell division and enlargement, N fixation in legumes, resistance to plant diseases, transformation of sugar to starch, and transporting of the genetic traits. Adequate P availability is also required for laying down the primordia of plant reproductive parts during the early phases of plant development.

Phosphorus is the second most important macronutrient required by the plants, next to nitrogen. Yet, the availability of soluble forms of P for plants in the soils is limited because of its fixation as insoluble phosphates of iron, aluminum, and calcium in the soil [2, 6–8]. Most soils possess considerable amounts of P, but a large proportion is bound to soil constituents. Soil with low total P can be supplemented with P fertilizer but are not able to hold the added P. About 75–90% of the added chemical P fertilizer is precipitated by metal-cation complexes and rapidly becomes fixed in soils and has long-term impacts on the environment in terms of eutrophication, soil fertility depletion, and carbon footprint.

Microorganisms are integral in the natural phosphorus cycle. The use of phosphate solubilizing microorganisms (PSMs) as biofertilizers for agriculture enhancement has been a subject of study for years.

Natural "K" Solubilization

Potassium (K) is considered as an essential nutrient and a major constituent within all living cells. Naturally, soils contain K in larger amounts than any other nutrients; however, most of the K is unavailable for plant uptake. Application of chemical fertilizers has a considerably negative impact on environmental sustainability. It is known that potassium solubilizing bacteria (KSB) can solubilize K-bearing minerals and convert the insoluble K to soluble forms of K available to plant uptake. Many bacteria have capacity to solubilize K minerals (e.g., biotite, feldspar, illite, muscovite, orthoclase, and mica). KSB are usually present in all soils, although their number, diversity and ability for K solubilization vary depending upon the soil and climatic conditions. KSB can dissolve silicate minerals and release K through the production of organic and inorganic acids, acidolysis, polysaccharides, complexolysis, chelation, and exchange reactions. Hence, the production and management of biological fertilizers containing KSB can be an effective alternative to chemical fertilizers. This article presents an overview of current trends and challenges on KSB, mechanisms and their role in plant growth promotion, and eventually gives some perspectives for research on K in agriculture.

K is present in several forms in the soil, including mineral K, non-exchangeable K, exchangeable K, and solution K. Interrelationships of various forms of soil K are shown in Figure 1. Depending on soil type, from

90 to 98% of soil K is mineral K and most of this K is unavailable for plant uptake (Sparks and Huang, 1985). Minerals containing K are feldspar (orthoclase and microcline) and mica (biotite and muscovite). The non-exchangeable form of K makes up approximately 1 to 10 % of soil K and is trapped between the layers or sheets of certain kinds of clay minerals (Sparks, 1987). Solution K is the form of K that directly and readily is taken up by plants and microbes in soil. In addition, this form is most subject to leaching in soils. The concentration of soil solution K varies from 2 to 5 mg l^{-1} for normal agricultural soils (Sparks and Huang, 1985).

Conclusions

Environmental stresses are becoming a major problem and productivity is declining at an unprecedented rate. Our dependence on chemical fertilisers and pesticides has encouraged the thriving of industries that are producing life-threatening chemicals and which are not only hazardous for human consumption but can also disturb the ecological balance. Biofertilizers can help solve the problem of feeding an increasing global population at a time when agriculture is facing various environmental stresses. It is important to realise the useful aspects of biofertilizers and implement its application to modern agricultural practices. The new technology developed using the powerful tool of molecular biotechnology can enhance the biological pathways of production of phytohormones. If identified and transferred to the useful PGPRs, these technologies can help provide relief from environmental stresses. However, the lack of awareness regarding improved protocols of biofertilizer applications to the field is one of the few reasons why many useful PGPRs are still beyond the knowledge of ecologists and agriculturists. Nevertheless, the recent progresses in technologies related to microbial science, plant-pathogen interactions and genomics will help to optimize the required protocols. The success of the science related to biofertilizers depends on inventions of innovative strategies related to the functions of PGPRs and their proper application to the field of agriculture. The major challenge in this area of research lies in the fact that along with the identification of various strains of PGPRs and its properties it is essential to dissect the actual mechanism of functioning of PGPRs for their efficacy toward exploitation in sustainable agriculture.

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Impact of Climate Change on Soil Salinity and Ameliorative Measures

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Pradeep[1]
[1]Ph d scholar, Dept of soil science and agricultural chemistry, GKVK, Bengaluru, Karnataka -560065.

Introduction

In the arid and semi-arid regions, soil salinity is one of the largest global challenges that severely affects agricultural production. Soil salinity has covered 20 % of total cultivated and 33 % of the irrigated agricultural lands worldwide and expected to increase at a faster rate than now by the year 2050. Recently, the alarming impact of climate change on the build-up of soil salinity has attracted widespread research attention. The rise in atmospheric greenhouse gases concentration with consequent increase in air temperature and decline in relative humidity together with extreme events of rainfall are probable indicators of climate change that have huge impact on the pace of soil salinity development (IPCC, 2013). The climate change accelerates salt water intrusion into fertile soils due to sea level rise, and excess groundwater extraction in the dry regions of the world also increases soil and groundwater salinity.

Conventional field-based monitoring of soil salinization over a vast area is not time and cost effective. Satellite remote sensing is providing an opportunity for continuous monitoring of soil salinity in spatial and temporal scale. The reflectance from different salinity concentrated soil types is sensitive to near-infrared (NIR) to shortwave infrared (SWIR) wavelength. Many indices have been developed for remote sensing-based soil salinity mapping such as Salinity Index (SI), Soil Adjusted Vegetation Index (SAVI) and band ratio between NIR and visible red (VR) band.

Impact of Climate Change on Soil Functions

Direct impacts of climate change on soil functions: Soil-climate models assuming constant inputs of carbon to soils from vegetation predicts the expected changes in temperature, precipitation and evaporation with a concomitant increase in organic matter turnover facilitating increased losses of CO2 in mineral and organic soils. These losses of soil carbon will also affect other soil functions like poorer soil structure, stability, and topsoil water holding capacity, nutrient availability and erosion.

Indirect impacts of climate change on soils: The integrated impact of climate change is expected to generally increase crop yields (with winter wheat, sunflower and sugar beet) as a result of the combined effects of CO_2 fertilization, radiation use efficiency and longer growing seasons which mostly applies to species with the C3 photosynthetic pathway and not necessarily to species with the C4 pathway. Elevated CO_2 increases the size and dry weight of most C3 plants and plant components.

Interrelationship Between Soil Salinity, Climate Change and Food Security

Climate change refers to long-term changes in weather conditions and climate systems. As a result, the global air temperature has increased by 1.5 °C above the pre-industrialization level, and the rise in CO_2 concentration in the atmosphere has gone up 20 µmol/mol per decade since 2000, and now it has reached >400 µmol/mol. Consequently, following drastic changes have already been.

Observed, which greatly influence the development of soil salinity:

1. Increase in the frequency of extreme weather conditions such as rise in air temperature, evaporation rate, excessive rainfall and heat stress.
2. Global warming due to increased concentration of GHGs (e.g., CO_2, N_2O, CH_4) which trap the heat within the atmosphere.
3. Spatial and temporal variability of rainfall distribution leads to changes in soil moisture contents.
4. Increase in precipitation leads to soil erosion, groundwater recharge, infiltration and storage, whereas rise in temperature promotes the transpiration and moisture depletion from the soil profile.

5. Rise in sea-level and sea water intrusion in the coastal areas limit their application for irrigation. It is projected that 130 million people will be inundated by the rise in sea level within 120 years Besides, excessive use of mineral fertilizers and groundwater during the post green revolution era added neutral soluble salts to the soil, which in turn contributed to salinity build up.

Reclamation and Management Strategies

Climate-smart agriculture is considered a pragmatic approach for ensuring food security in the challenging environment. The Climate Smart Management Practices (CSMPs) include site-specific reclamation management strategies (viz., amendments, irrigation and drainage), applications of microorganisms, halophytes, land use pattern change, innovative irrigation and drainage strategies and use of stress-tolerant genotypes. These practices may deliver co-benefits in the forms of reduced GHG emission, enhance soil carbon sequestration and ecosystem services. Therefore, CSMPs are the need of the hour to tackle soil salinity under current and future climatic conditions.

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Soil Quality: Why and How?

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Rashmi C. M.[1], Pradeep[1]

[1]Ph.D Scholar, Dept of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka -560065.

Introduction

The soil quality concept evolved during 1990s in response to increased global emphasis on sustainable land use. Soil quality concept is important because of the multiple functions (e.g., food and fiber production, recreation, and recycling or assimilation of wastes or other by-products) that soil resources must provide.

Soil is a key natural resource, with the advancement of agriculture, soils are being degraded at an alarming rate by wind and water erosion, desertification, salinization misuse and improper farming practices so maintenance of soil quality is most precious.

Why Soil Quality is Important?

1. Because 10 % of the land area is soil
2. Of the 13 billion ha of land area on Earth, cropland accounts for only 11%.
3. 70 -78% of the energy needs is met by crops grown directly on soil
4. 20% derived indirectly from soil (meat, eggs and milk).
5. This fragment competes with all other needs (housing, cities, industries, etc., etc.)
6. To Ensure equitable access to food and foster good health with economic growth.
7. Environment regulatory function with particular reference to water quality and greenhouse effect.

Definition of Soil Quality

The capacity of a specific kind of soil to function, with in natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation (Karlen *et al.* 1997).

Features of Soil Quality

Inherent Soil Quality: resulting from natural soil forming factors e.g., Texture. Soil forming factors are:

a. Climate.
b. Vegetation.
c. Parent material.
d. Relief.
e. Time.

Dynamic Soil Quality: Resulting from changes due to human use and management e.g., BD, SOM.

a. Soil amendments
b. Drainage or Irrigation
c. Cropping History and Rotation
d. Nutrient Management
e. Land Use Type
f. Residue Management
g. Tillage.

Soil Quality Indicators

Soil quality indicator is a parameter which measures soil properties that influence the capacity of the soil to perform a specific function.

Soil Quality Index: A set of aggregated or weighted soil quality parameters**.**

Criteria for Selection of Soil Quality Indicators

1. Correlate well with natural processes in the ecosystem.
2. Integrate soil physical, chemical, and biological properties and processes.
3. Relatively easy to measure.
4. Sensitive to variations in management and climate.

Types of Soil Quality Indicators

1. Visual indicators: these are identified based on expert's opinion and using photographs. e.g., soil colour.
2. Physical indicators: bulk density, surface crust, surface soil depth, aggregation etc.
3. Chemical indicators: pH, EC, OC, available nutrients.
4. Biological indicators: microbial biomass carbon, microbial biomass nitrogen, phosphatase activity etc.

Key Soil Quality Indicators for Soil Quality Assessment

Selected indicator	Rationale for selection
Organic matter	Defines Soil fertility & soil moisture
Topsoil- depth	Estimate rooting volume for crop production
Aggregation	Soil structure, erosion resistance
Texture	Retention & transport of water & chemicals
Bulk density	Plant root penetration, porosity
Ph	Nutrient mobility
EC	Crop growth, infiltration
Suspected pollutants	Plant quality, & human & animal health
Soil respiration	Biological activity
Extractable N, P & K	Capacity to support plant growth

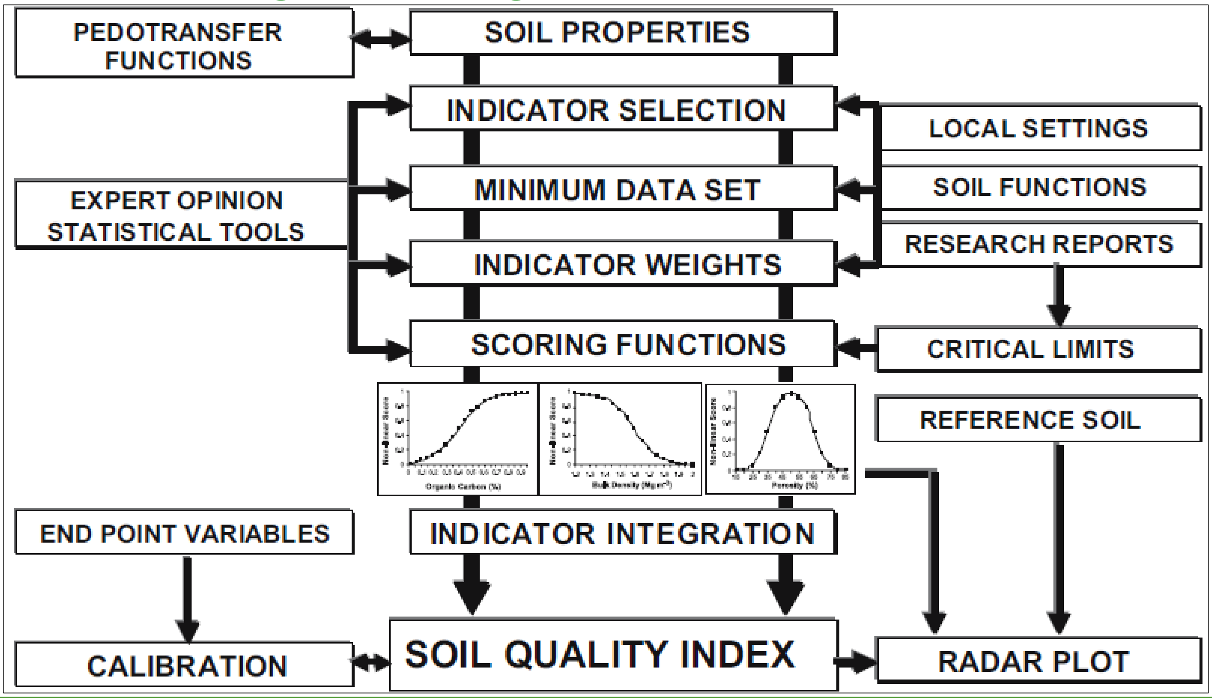
Assessment of Soil Quality

The art and science of creating decision tools for sustainable land management.

Types of Soil Quality Assessment

1. Qualitative approach
2. Quantitative approach.

Reclamation and Management Strategies



Soil Health Score Card - A Qualitative Approach

Depicts the capacity of soil to perform both soil function and its attributes. It is very informative and relatively easy to measure also. In score card each soil indicator is rated as below:

Scale rates	Performance of soil	Scale range
Healthy	Optimum	3-4
Impaired	Abnormal	1.5-2.5
Unhealthy	Inability	0-1

Conclusion

Assessment and monitoring of soil quality must also provide opportunity to evaluate and redesign soil and land management systems for sustainability. We need standards of soil quality to determine what is good or bad and to find out if soil management systems are functioning at acceptable levels of performance. Assess the current status of the biological, physical, and chemical properties of soil hence, support for ecological sustainability.

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Nanotechnology - A Recent Approach for Enhancement of Phosphorus in Crops

Article ID: 35122

Rashmi C. M.[1], Pradeep[1]

[1]Ph.D Scholar, Dept of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka -560065.

Introduction

Phosphorus (P) takes its rightful place alongside Nitrogen and Potassium among the three primary macronutrients which are essential for successful plant growth. These three essential elements are to be managed in such way that their use efficiency is high so that food and nutritional security could be achieved with minimal environmental risk. Among these three primary nutrient elements P is widely deficient in soils of the world in general and Indian soils in particular next to nitrogen. Phosphorus use efficiency in most crops will be around 15 to 20 per cent.

Functions of Phosphorus in Plant

Phosphorus is a part of the nucleic acid structure of plants which is responsible for the regulation of protein synthesis. Phosphorus plays a major role in the growth of new tissue and division of cells. Plants perform complex energy transmissions, a function that requires phosphorus. Without Phosphorus, photosynthesis could not occur. Phosphorus plays a key role in complex energy transformations that are necessary to all life, as a main ingredient in ATP (adenosine triphosphate). It is also a central component of DNA and RNA – and is necessary for building proteins and other compound.

Need of Nanofertilizers

In the past 50 years, the fertilizer consumption exponentially increased from 0.5 (1960's) to 24 mt (2013). The optimal NPK fertilizer ratio of 4:2:1 is ideal for crop productivity while the current ratio is being maintained at 10: 2.7: 1 in India. The fertilizer response ratio in the irrigated areas of the country has decreased from 13.4 kg grain / kg nutrient applied in 1970's to just 3.7 kg in 2005. About 27 kg NPK/ ha was required to produce one tonne of grain in 1970 while the same level of production can be achieved by 109 kg NPK/ha in 2008. The extent of nutrient deficiencies in the country is in the order of 89, 80, 50, 41, 49 and 33% for N, P, K, S, Zn and B, respectively.

Importance of Nanofertilizers

1. Nano particles increase nutrients use efficiency
2. Decrease in residual effect
3. Production of safe and nutritious food.
4. They minimize cost and maximize profit.
5. Enhance plants growth and increase in productivity
6. They are nontoxic.

Methods of Synthesis of Nano Phosphorus Fertilizers

1. Synthesis of Rock phosphate nano particle by physical method (Adhikari *et al.* 2014): Rock Phosphate (34% and 31%) collected from Udaipur, Rajasthan, size of RP reduced to nano size with help of 24 blade Rotary Mill, repeated this process for 5 times then material was ball milled thu rock phosphate nano particle was synthesized.

2. Wet cemical synthesis of Hydroxyapatite Nano particles (Taskin *et al.* (2017): The nHA was synthesized by the wet chemical precipitation method, using calcium nitrate tetrahydrate ($Ca(NO_3)_2 \cdot 4H_2O$) as the source of calcium, diammonium hydrogen phosphate ($(NH_4)_2HPO_4$) as P source.

3. Biosynthesis of nano slow-release phosphate and potash fertilizer (Rajendran *et al.* (2017):

a. Phosphate Nano SRF prepared by mixing 10mL of component A and 100g of component B.

b. Component A: Emulsion of rock phosphate and potash were prepared by sonicating 0.25g of rock phosphate and potash in 10ml of neem oil for 30 min at 0.5 cycles and 80 amplitude.

c. Component B: Neem cake powder (100g) blended with 1×10^8 CFU/g of PGPR.

d. Pelletized Nano SRF should be characterized.

Conclusion

By applying phosphorus in the form of nano fertilizers allows better dissolution, faster absorption and assimilation by the plant compared to conventional fertilizers thus, employing nanotechnology in synthesis of nano phosphorus fertilizers and their subsequent use is regarded as a breakthrough in achieving higher nutrient use efficiency with minimum environmental risk. Application of Nano zeolite phosphorus fertilizer plays a significant role in enhancing phosphorus content, uptake and yield components of peanut crop through improving the use efficiency of nutrient.

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Iron Toxicity in Wetland Rice

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Rashmi C. M.[1], Pradeep[1]
[1]Ph.D Scholar, Dept of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka -560065.

Introduction

Iron is the 4th most abundant element in the earth's crust after O, Si & Al. It ranges in soil from 1- 5 % of total iron in plough layer and in plants its concentration is usually > 50 ppm. Iron occurs in 2 oxidation states: Ferric (III), Ferrous (II). Availability of Fe is pH dependent (acidic pH). Fe is predominantly present in the primary and secondary ferromagnesian silicates.

Forms of Iron are

1. Iron included in primary and secondary minerals
    a. Eg: primary minerals- biotite, hornblende, augite, olivine etc.
    b. Secondary minerals- clay minerals.
2. Iron bound to organic matter.
3. Oxides and hydroxides.
4. Soluble Iron Fe^{2+}

Role of Iron in Plant

Iron helps in chlorophyll development. Iron is a component of ferredoxin which is the first stable redox compound formed during photosynthetic electron transport chain. Iron is a constituent of certain enzymes like catalases, peroxidases and it is also a component of some of the haeme proteins. Iron helps in cellular plant respiration. Iron is involved in N- fixation as it is a component of leghaemoglobin.

Soil Reduction and Iron Toxicity

Soils on which rice is grown can experience a range of redox potential. Data on the range of redox potentials encountered in soils ranging from well drained to flooded conditions are summarized in following table, and can serve as a useful guideline for classifying soil reduction under diverse soil conditions.

Soil reduction is a process in the submerged soils which greatly influences Fe toxicity in wetland rice. Soil reduction mobilizes Fe (II) in soil solution. The concentration of Fe (II) is negligible in non -reduced soils. Some of the reduction products, such as dissolved sulfides, may increase the susceptibility of the rice plant to Fe toxicity. Production of reduced organic substances may interfere with Fe toxicity through their influence on rice plant root growth.

Chemistry of Iron Under Submergence

The concentration of Fe (II) in soil increases following flooding due to reduction of Fe (III) oxide by bacteria oxidizing organic matter. The reduction of Fe (III) to Fe (II) takes place at a redox potential of 180–150 mV.

A rapid increase in Fe (II) following flooding is favoured by low initial soil pH, a sustained supply of organic matter, the presence of easily reducible Fe, a high fertility status of the soil and the absence of compounds with a higher oxidation state than Fe (III) oxide, especially oxygen, Mn (III, IV) oxide, and nitrate in the soil. The reduction of Fe (III) to Fe (II) can be illustrated by the following equation:

$Fe(OH)_3 + e^- \leftrightarrows Fe^{2+} + H_2O$

The Intensity of Reduction of Iron

1. Duration of submergence.
2. Amount of organic matter.
3. Active Fe content etc.

Iron Toxicity

Iron toxicity is a disorder associated with large concentrations of Fe^{2+} in the soil solution. Although most mineral soils are rich in iron, the expression of toxicity symptoms in leaf tissues and a reduction in rice yield occur only under specific flooded conditions, which involve the microbial reduction of insoluble Fe (III) into soluble Fe (II). A wide range of soil types can be iron-toxic, including acid sulphate soils, acid clay soils, peat soils, and valley-bottom soils receiving interflow water from adjacent slopes. The Fe2+ concentrations in the soil solution that reportedly affect lowland-rice yields can range from >3000 ppm and in plants when the concentration exceeds 300 ppm. Iron-induced yield reduction is frequently associated with a poor nutrient status of the soil or with accumulation of respiration inhibitors. Hence, iron toxicity may be described as a multiple nutritional disorder hastened by, but also increasing conditions of P, K, and Zn deficiency and H_2S toxicity.

The expression of iron-toxicity symptoms in rice requires excessive uptake of $Fe^{2+}$by roots and its acropetal translocation *via* xylem flow into the leaves. Inside the leaf, excess amounts of Fe^{2+} cause an elevated production of radicals which can irreversibly damage cell structural components and lead to an accumulation of oxidized polyphenols. The typical visual symptom associated with those processes is the "bronzing" of the rice leaves. Rice-yield losses associated with the appearance of bronzing symptoms commonly range from 15% to 100%. However, in the case of severe toxicity, complete crop failure can occur. Overcoming rice-yield reductions caused by iron toxicity requires both adapted and tolerant varieties as well as appropriate management interventions.

Conditions Enhancing Iron Toxicity

1. Low lands adjacent to uplands.
2. Lower temperature and high rainfall.
3. Soil pH.
4. Organic matter.
5. Poor nutrient status (K, P, Ca, Mg, Zn, Si).
6. High salt content.

Iron Toxicity can be Managed by

1. Use of iron tolerant varieties
2. Amelioration through use of lime, Basic slag, etc.
3. Balanced nutrient management
4. Proper water management.
5. The application of essential plant nutrients can reportedly counteract negative effects of excess amounts of iron by competing with Fe^{2+} for uptake and ion adsorption sites at the root or by enhancing plants defence or tolerance mechanisms.
    a. Potassium seems to play an important role in regulating Fe in the rice plant, both as competing ion and by reducing root exudation.
    b. The activity of SOD is essential for the detoxification of super oxide radicals in tissues, and Zn is a component of SOD isoenzymes.
    c. Application of P, K, Ca, Mg and Zn - reduce bronzing symptoms and increase rice yield.

Conclusion

The application of other plant nutrients mitigates Fe toxicity through their role via root functions related to reducing the amount of iron taken up by the plant by oxidation, exclusion, or retention of iron. Thus, it can be managed by the best use of antagonistic property of nutrients interaction in managing iron toxicity.

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Effect of Soil Management Practices on Soil Enzyme Activities

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Rashmi C. M.[1], Pradeep[1]
[1]Ph.D Scholar, Dept of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka -560065.

Introduction

Soil enzymes are the mediators of the most biochemical processes that are critical for soil functioning such as organic matter decomposition, nutrients mobilization and elements cycling. Enzyme activities are sensitive to the soil management practices such as tillage, fertilization and cropping. Generally, soil management practices alter important soil characteristics that may directly or indirectly affect the activities of soil enzymes i.e., soil pH, moisture, organic matter content, nutrient availability and the composition of the microbial community. Studies of microbial biomass carbon, nitrogen and enzyme activities provide information on the biochemical processes occurring in the soil and there is growing evidence that soil biological parameters may have a potential as early and sensitive indicators of changes in soil health.

Functions of Enzymes in Soil

Enzymes play key biochemical functions in the overall process of organic matter decomposition in the soil system and are important in catalyzing several vital reactions necessary for,

1. Life processes of micro-organisms in soils.
2. Stabilization of soil structure.
3. Organic matter formation.
4. Nutrient cycling**.**

Importance of Soil Enzymes

1. Release of nutrients into the soil by means of organic matter decomposition.
2. Identification of microbial activity.
3. As sensitive indicators of ecological change.

Enzymes are Considered as Useful Indicators of Soil Quality, because they are

1. Closely related to soil organic matter, soil physical properties and microbial activity.
2. Changes much sooner than other parameters, thus providing early indications of changes in soil health.
3. Involve simple procedures for determination of their activity.

Important Enzymes Involved in SOM Dynamics and Nutrient Cycling are as Follows

1. Glucosidase.
2. Galactosidase.
3. Glucosaminidase.
4. Aspartase.
5. Asparginase.

Effect of Soil Management Practices on Soil Enzyme Activities

Soil management practices are those practices which are followed by the farmers to conserve the soil resources, they are as follows:

1. Crop rotation.
2. Long term fertilization.
3. Conservation practices.
4. Application of soil amendments.

5. Pesticide application.
6. Tillage and cultivation etc.

The Factors Affecting the Enzyme Activity are Listed Below

1. Substrate concentration: The activity of an enzyme also increases with the increase in substrate concentration. If the substrate concentration increases, then the availability of the active site would decrease. This will affect the activity of an enzyme and limit the reaction rate.

2. pH: Each enzyme has its optimal pH in which they work. For example, pepsin and trypsin work on acidic pH. The enzymes are globular proteinaceous structure, form by the interaction of the hydrogen bond between the side chains of the protein. Any change in the cause deionization of side chain which results in the denaturation of the enzyme**.**

3. Temperature: Each enzyme works on its optimal temperature. Any alteration in temperature affects the activity of an enzyme, and it also leads to denaturation of an enzyme.

4. Enzyme cofactor and coenzyme: Each enzyme requires cofactors (inorganic ion or protein organic molecules) for their work. The non-availability of these cofactors decreases the activity of an enzyme.

5. Enzyme inhibitors: The inhibitors of an enzyme bind to the active site which affects the activity of an enzyme.

Conclusion

Among the soil management practices crop cover, tillage method and residue management lead to significant changes in the soil physico-chemical and biological properties and thus, affect the composition, distribution and the activities of the soil microbial communities and the production of enzymes. So, better soil management practices play a prominent role in maintaining soil health.

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Molecular Approaches to Study Virus Vector Interactions and their Impact in Management of Vectors in Vegetable Ecosystem

Article ID: 35125

Y. Peeru Saheb[1]
[1]Department of Entomology.

Vegetable crops are largely cultivated in tropical and sub-tropical regions of the world. Plant virus diseases cause tremendous economic losses, particularly in the tropical conditions. Most plant viruses depend on vectors for their survival and spread (Ambethgar., 2015).

Viruses comprise almost half (47 %) of the reported plant emerging infectious diseases. Detection and identification of existing, emerging and new viruse vector interactions have been relied on a large range of techniques viz., biological assay, electron microscopy, nucleic acid-based techniques like polymerase chain reaction (PCR) and its variants, serology-based techniques such as enzyme linked immunosorbent assay (ELISA) and more recently microarrays. The present era of molecular biology is witnessing revolutionary developments in sequencing technology. Next generation high-throughput sequencing technology has made it possible to directly detect, identify and discover novel viruses in several plants. A novel *Cucumo virus* was identified from deep sequencing of long cDNA reads (Prabha *et al*., 2013)**.**

Using coat protein and RT-PCR Potato *yellow vein virus* (PYVV) in *Solanum phureja* was confirmed. (Carlos and Monica, 2014). RNAi-Mediated Resistance to Cucumber Mosaic Virus (CMV) in Genetically Engineered tomato was reported. Generated an RNAi construct containing inverted repeat of 1138 bp fragment of a partial replicase gene of CMV-O and used it to produce transgenic tomato plants expressing CMV-specific dsRNA of the replicase gene (Ntui *et al*., 2014).

Virus resistance technologies such as pathogen derived resistance which include protein mediated resistance, coat protein mediated resistance, replicase mediated resistance, movement protein mediated resistance, RNA-mediated resistance and non-pathogen derived resistance includes RNA interference (RNAi), plant disease resistance genes, Ribosomal inactivating proteins, protease inhibitors from plants, systemic acquired resistance. Key components of the RNA silencing pathways have been shown to have an important protective role against invading viral pathogens. Next-generation sequencers have hastened up the advancement in hunting for viruses and their diagnostics by metagenomic analysis and deep sequencing. It overcomes the inherent draw backs of Sanger sequencing in throughput, scalability, speed, and resolution (Bologna and Voinnet, 2014).

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Nitrate Leaching and threat of Ground Water Contamination in Sugarcane Based Cropping System of Bihar

Article ID: 35126

Sayan Chattopadhyay[1], Ajeet Kumar[2], Sanjay Kumar Singh[3]
[1]M.Sc. (Ag.) Research Scholar, Department of Soil Science, Faculty of Agriculture, DRPCAU, Pusa (Samastipur), Bihar-848125, India.
[2]Assistant Professor-cum-Scientist, Department of Soil Science, Sugarcane Research Institute, DRPCAU, Pusa (Samastipur), Bihar-848125, India.
[3]Assistant Professor-cum-Scientist, Department of Soil Science, Tirhut College of Agriculture, Muzaffarpur, DRPCAU, Pusa (Samastipur), Bihar.

Abstract

Sugarcane is a tropical plant and grown as cash crop. In India it is the main source of sugar. To pursue high yield, farmers of Bihar generally use heavy dose of nitrogenous fertilizer (300-400 kg N ha $^{-1}$) which is much more than the recommended dose (150 kg N ha $^{-1}$). The applied N fertilizer either absorbed by the crops or stored in the root zone, and lost by ammonia volatilization, nitrogen leaching, N_2O and N_2 emissions. The NO_3^- N accumulated in the root zone move downward by percolated soil water, and eventually enters the groundwater. The overuse of nitrogen fertilizer, heavy rain in monsoon and abundant irrigation caused severe nitrogen leaching and increases the risk of groundwater contamination with nitrate. Therefore, it is necessary to manage the water and nitrogen fertilizer to ensure optimum yield potential, sustainable use of groundwater resources and maintain the health of human as well other animals. The aim of the present status paper is to provide insight regarding nitrate contamination in groundwater in the sugarcane growing areas of Bihar. It is essential to develop strategies to control accumulation of NO_3^- in soil and their leaching from the soil and also maintain the yield potential of sugarcane.

Introduction

Sugarcane and sugar beet are the main sources of sugar. Out of total sugar produced in the world 60 per cent is obtained only from sugarcane. Sugarcane is a tropical plant and grown as cash crop. Asia is the largest producer of sugar followed by Europe. Most of the sugar in Asia comes from sugarcane. The global production of raw sugar is 112 mt. India stands second in area (5.01 m. ha) and production (352.14 m.t) among the sugarcane growing countries of the world. Uttar Pradesh has the largest area almost 50 per cent of the cane area in the country, followed by Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, Gujarat, Bihar, Haryana and Punjab. Sugarcane is a long duration crop that requires a high quantity of nutrients. Moreover, continuous planting of sugarcane in the same field depletes the soil nutrients. A crop having yield of 100 t ha^{-1} removes 207 kg N, 30 kg P_2O_5 and 233 kg K_2O from the soil (Jagtap *et al*., 2006). Therefore, these elements must be added in adequate quantities to obtain higher yield. Among these elements N is the primary nutrient limiting sugarcane production (Wiedenfeld and Enciso, 2008). Differences in soils, environmental factors and sugarcane cultivars limit the usefulness of research from other areas. World recommended rates of N fertilizer for sugarcane production vary between 45 and 300 kg ha^{-1} yr^{-1} (Srivastava and Suarez, 1992) Dry matter accumulation increased significantly when a high N rate (225 kg ha^{-1}) was compared with 175 or 150 kg N ha^{-1} (Lal, 1991). The large amounts of N fertilizer applied to most cropping systems support high yields but may result in excessive N levels in groundwater or surface water (Robinson *et al*., 2007). Nitrogen use efficiency (NUE) has been well studied in many crop species, especially grain crops, where kernel N content is a key harvest index. In contrast NUE in sugarcane has not been properly understood, since N is an insignificant component of the harvested product. However, increasing concerns about pollution from N run off due to excessive fertilization demand an improved understanding of NUE in sugarcane, so that applied N is effectively utilized (Whan *et al.,* 2007). Moreover, unlike in cereals, the longer span of sugarcane growth presents different challenges for efficient N use. For many locations, the depletion of plant-available soil N over time justifies the need for split application of the yearly total N rate. Wiedenfeld (1997) observed a progressive decline in soil NO_3 concentration with delay in soil sampling after N fertilizer application. Proper land management programs should include the establishment of fertilization regimes that optimize growth with minimum nutrient leaching (Van Miegroet *et al.,* 1994). These involve adjusting fertilizer application rates and frequencies to maximize N utilization while minimizing N leaching from the rooting zone (Lee and Jose, 2005).

Sugarcane Production in Bihar

In sub-tropical region, Bihar is second largest sugar producing state next to Uttar Pradesh with an area of about 3.15 lakh hectares, but its share in area under sugarcane is only 4.90 percent and in production is 4.31 percent of all India production which is very low, with an average yield of 65.0 tonnes/ha, which is below the national average (70.10 tonnes/ha). North Bihar is suitable for producing good quality sugarcane with minimum inputs as compared to other states. The district of West Champaran, East Champaran, Gopalganj, Sitamarhi, Siwan and Samsatipur are the main area of sugarcane production in the state, which do not only account for nearly 70 percent cane area but 60 percent of annual cane production of the state. It also accounts for 10 sugar factories out of 28 sugar factories of state.

Fate of Nitrogenous Fertilizers in Soil

Nitrate is a polyatomic ion and a common component of fertilizers. Almost all inorganic nitrates are soluble in water. Beside nitrate containing fertilizers ammonium containing fertilizers also contribute towards the nitrate content of soil. NH_4^+ from ammoniacal nitrogenous fertilizers readily oxidized to NO_3^- through nitrification. Hence, there is always accumulation of NO_3^- ions, which are either taken up by the crop, immobilized by soil microbes or undergo leaching to the lower soil horizons as they are readily soluble by water. Nitrate ions, being more mobile than NH_4^+ ions, are more prone to leaching loss.

Application rates of nitrogenous fertilizer by the local farmers in this area often exceed crop requirements, resulting in high accumulation of nitrate in the soil. The impact of downstream nutrient export from agricultural lands continues to be of much more concern. Nitrate-nitrogen is particularly troublesome as it leaches through the soil into subsurface or groundwater, which ultimately leads to surface waters. Permeable soils make the region susceptible to groundwater pollution by NO_3^- N, which is applied to fields in large amounts as fertilizer. Nitrate that has accumulated in soils is highly prone to leaching, which is directly threatening the quality of groundwater. Traditional farming practices within this region typically involve application of significant amounts of nitrogenous fertilizer (300-400 kg N/ha) Combined with abundant supplies of irrigation water and annual rainfall (1236 mm/year) received as large events during a distinct wet season, the potential exists for farm related nitrate flux to rivers via both runoff and deep-drainage to ground water.

Use of Nitrogenous Fertilizer

The range of recommended dose of nitrogen for Sugarcane cultivation in Bihar is 150 kg N ha^{-1}. One of the main problems with nitrogen fertilization in sugarcane is the low N recovery by the crop, between 10 to 40% as measured in the field using ^{15}N tracer isotope (Chapman *et al*., 1994). Traditional farming practices within this region typically involve application of significant amounts of nitrogenous fertilizer (300-400 kg N/ha) Combined with abundant supplies of irrigation water and annual rainfall (1236 mm/year) received as large events during a distinct wet season, the potential exists for farm related nitrate flux to rivers via both runoff and deep-drainage to ground water. The leaching of nitrate below the rooting zone represents a loss of plant nutrient and can contribute to pollution of groundwater aquifers and eutrophication of surface waters (Pyerzynski *et al*., 1994).

N-fertilizer and Ground Water Pollution

Agricultural land use represents the largest diffuse pollution threat to groundwater quality on a global scale (Haller, 2013). Nitrate is one of the main groundwater pollutants, with one part nitrogen and three parts oxygen. This form of nitrogen is usually found in water. High nitrate concentrations in groundwater can cause health risk and environmental pollution that have already become a common problem in many parts of the country. In a recent year, more than 1.1 worldwide billion people lack of safe drinking water (Prasad, 2006). Water quality around the agricultural areas has deteriorated by the leaching of fertilizers and pesticides due to the intensive agricultural practices (Scanlon *et al*; 2007). Nitrate, considered as common contaminant, leading toxic algal blooms, decreasing dissolved oxygen leading to loss of several species in aquatic systems. It is found that NO_3^- lost from soils and eventually accumulates in groundwater which people use for drinking water, due to intensive use of nitrogen fertilizers. Drinking water with high NO_3^- concentration can cause methemoglobinemia. In general, nitrate concentrations occurring in groundwater are naturally less than 2 mg/L. The safe limit of nitrate in drinking water is up to 10 mg/L (WHO standard). As a result of Agricultural activities, the Nitrate concentration can easily reach several hundred milligrams per L (WHO, 1985b). For example, concentration of up to 1500 mg /L was found in ground water in agricultural area of India (Jacks & Sharma, 1983).

Human Health Associated with Nitrate Contamination

Nitrate concentration in drinking water starts affecting the health of the populace at levels in the range of 100 to 200 mg/L of water. Consuming too much nitrate can be harmful especially for babies. It can affect blood carries oxygen and cause Methemoglobinemia/blue baby syndrome that eventually leads to developing an intestinal cancer. Actually, Blood contains hemoglobin, which carries oxygen. When nitrate is present, hemoglobin can be converted to methemoglobin, which cannot carry oxygen. In the blood of adults, certain enzymes continually convert methemoglobin back to hemoglobin, and methemoglobin levels normally do not exceed 1%, while infants have lower levels of these enzymes, and their methemoglobin level is usually rise up to 1% to 2 % which is fatal to infants.

Conclusion

Strategies should be made to improve fertilizer and water use efficiency, reduce nitrate leaching and contamination of groundwater without reduction in yield. The quantification, nitrate uptake by sugarcane, nitrate leaching in soil profile and its contamination in ground water under sugarcane based cropping system in cane belt of Bihar is essentially, so that resident of the area may get rid of the nitrate problems.

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Algal An Advanced Fuel

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T. Surya[1], S. Sundhar[1], M. Balamanikandan[1]
[1]Fisheries College and Research Institute, Thoothukudi.

Introduction

Algae are diverse organisms found throughout the world in and near bodies of water. Most algae are photosynthetic/autotrophic, some are heterotrophic which derives energy from uptake of organic carbon such as cellulosic material. Algae replicates naturally and produce oils, proteins, alcohols, and biomass, nowadays they have attracted the attention of researchers and industrial producers as an alternative to oil. Algae thrives organic carbon or CO2 and nutrients such as nitrogen and phosphorus. Growth conditions and the availability of sunlight, carbon and nutrients affect the metabolism of algae and whether they produce lipids or carbohydrates. Manipulation of nutrients has not proved successful in increasing algal productivity. It is a new fact that the algae naturally produce hydrocarbons – molecules that can replaces today's petroleum. Biotechnology targets to find ways to increase the reproductive rate, improve metabolism of inputs, and enhance the production of desired oils, fuel-grade alcohols in useful species. Many algae species are adaptable to genetic engineering, expressing complex proteins and accumulating recombinant proteins to very high levels.

Algal Classification

Algae are diverse group of simple organisms that differ from plants in reproductive and structural features. Based on the following aspects such as pigment composition, cell division process, flagellar apparatus, cell wall structure algae can be classified (Radmer 1996, Barsanti & Gualtieri 2006). With reference to the cell size, it can be classified simply as macroalgae and microalgae. Algae ranges from unicellular (microalgae) and to multicellular (macroalgae) forms such as microscopic single cells, macroscopic multicellular conglomerations, matted, branched colonies and complex leafy forms.

Algae Culture

Collect algae from both marine (salt water) and freshwater environments, culture and characterise them by microscopy and use DNA extraction/sequencing and metabolite analysis (including lipid accumulation profiles) to identify the best application for specific strains. The most promising algae are then used in an adaptive evolution (mutagenesis/selection) experiment to select for algae with certain attributes (e.g., fast growth or high lipid accumulation properties).

Algae as a Renewable Source

Microalgae are a great resource which can be farmed without any complex facility. Local strains that are efficient producers of lipids, crude protein and neutraceuticals (nutritional supplements). The Algae Biotechnology Group aims to sustainably produce biodiesel, protein-rich animal feed and other high value products from microalgae. "Non-GM" approach to strain improvement, meaning we prefer not to genetically modify algae.

Algae as Food Source

Algae are a cost-effective source of producing fuel, feed, and neutraceuticals all year round with minimal use of land. For example, oil yields from microalgae are approximately 10 times higher than from palm oil. This is an important prerequisite for large-scale commercial production of biofuels.

The main products created from algae:
1. Nutrient-based supplements such as omega-3 fatty acids.
2. Biodiesel.
3. Protein-rich cattle feed.
4. Phytosterols for the food industry.

Valuable Products from Algae

Macro algae harvested from natural habitats or cultivated at seashore areas are used traditionally as food and employed for the production of hydrocolloids, including agar, alginate and carrageenan that are used as thickening and stabilization agents in food, chemical and pharmaceutical industries (Carte 1996, Campanella et al. 1999, Otles & Pire 2001, Pulz & Gross 2004). The food industry uses are mainly in dairy and bakery products and as dietary supplements (Spolaore et al. 2006, Carlsson et al. 2007).

Macroalgae are cultivated mainly in the Asian countries, China, Japan and Korea as food due to their nutrient contents, especially vitamins, minerals and amino acids (Radmer 1996, Barsanti & Gualtieri 2006). The most cultivated macroalgae is the kelp Laminaria japonica, which is cultivated over 60% of the total production (Barsanti & Gualtieri 2006). The use of these seaweeds can also be attributed to their taste and texture (Jensen 1993). Other edible algae strains are; Caulerpa, Cladosiphon, Enteromorpha, Monostroma, Gracilaria, Hizika, Palmaria, Porphyra and Undaria. Especially Laminaria and Undaria are remarkable for their high ß-carotene and iodine content (Radmer 1996, Barsanti & Gualtieri 2006). The strains of Hizika and Palmaria have a great potential of minerals, especially high levels of in Fe and Cu, and Gracilaria is a high source of vitamin A (Barsanti & Gualtieri 2006, Carlsson et al. 2007). They contain high amounts of simple and complex carbohydrates which provide the body additional source of energy. In particular, the sulphated complex carbohydrates are thought to enhance the immune system's regulatory response (Carlsson et al. 2007). Algae are designated as a good protein source with essential amino acids, unlike most plant foods, that are involved in major metabolic processes and enzyme production. Compared to other protein sources, algae are low in fat and high in fibre (Spolaore et al. 2006). The high chlorophyll and phytochemical content make algae an effective antioxidant source for prevention cell damage and improving the immune system.

Commercial Development

Biofuel companies are currently seeking to scale commercial production of algae and are pursuing several engineering approaches – using closed systems and open pond systems – to the design of an economical system for growing algae. In closed systems, engineers can precisely regulate algae growth conditions. Closed systems include both photo bioreactors for photosynthetic algae strains and traditional bioreactors (enclosed tanks such as those used in fermentation and other microbial growth) for algae strains that feed on sugars. Open pond systems have been used in many settings, but can be sensitive to various environmental factors, such as invasion by other algae strains or variations in nutrient availability, heat and light. Since microalgae may be dispersed by wind or by fauna, open pond systems can introduce algal strains to the surrounding environment. The probability of dispersion by these methods is equivalent for natural and biotech strains. The potential environmental impact on surrounding environments including crops is also equivalent for natural and biotech algal strains. Pond systems covered by thin plastic films and combination closed/open systems are being developed to control these factors. An essential factor for commercialization is the development of an economical harvesting system and the recycling of residual biomass after the biofuel is extracted.

Regulatory Structure

All biotechnology products in the United States undergo rigorous regulatory oversight and approval processes. Under the Coordinated Framework for Regulation of Biotechnology, federal agencies have a broad mandate to assess the potential health and environmental impacts of organisms whose genetic material has been intentionally changed in a way that does not occur naturally. Over the biotech industry's 35-year existence, oversight and regulatory evolution have kept pace with scientific advancements, such as synthetic biology and metabolic engineering techniques. This framework will be able to incorporate algal biotechnology products and address any specific issues associated with individual algae technology platforms. The National Institutes of Health administers biosafety guidelines for laboratory research using recombinant DNA. The Environmental Protection Agency regulates the use of new intergeneric microorganisms in industrial processes, such as biofuel or biochemical production, under the Toxic Substances Control Act. New biotech products are also subject to environmental assessments under the National Environmental Policy Act and Endangered Species Act before commercial use. Under the Plant Protection Act, the USDA oversees the interstate movement, importation and introduction into the environment of any organism that may impact U.S. crops. Any biotech organism that incorporates genetic material from a known plant pest or noxious weed or from another organism that has not been classified is considered a potential plant pest. The Food and Drug Administration similarly regulates biotech products under the Federal Food, Drug and Cosmetic Act if they are expected to become a component or otherwise affect the characteristics of food, biopharmaceuticals or devices. Biotech agricultural products – such as corn and soybeans – have been used as animal feed, but are not considered to affect the characteristics of food from those animals.

Conclusion

Algae have been used as a human food since ancient times, particularly in China, the Korean Peninsula and Japan. They are consumed sometimes as part of a subsistence living and sometimes as a regular ingredient of salad-type preparations. The chemical composition of algae has made it useful to the food industry, as well as various areas of medicine and scientific research. Modern technology has made the derivation of many different substances from algae possible. Aside the main use in food industry, either as direct consumption or for production of bioactive compounds, current research is focused on Biofuel (biodiesel, bioethanol, bio-gasoline) production. The energy crisis hit the world in the recent decades has triggered off the race for invention of effective as well as cheap energy sources, and algal biomass are considered as an alternative to traditional sources since when burned they produce high levels of heat and electricity. Algae are one of the best examples for eco-friendly resources, as none of the products derived from algae are considered to be pollutants.

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Diversity of Mites

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Mr. Manoj Kumar Jena[1]
[1]P.G. Research Scholar, Department of Entomology, Navsari Agriculture University, Navsari, Gujarat.

Introduction

Mites are very tiny creatures capable of infesting and causing severe loss to a variety of agricultural and horticultural crops particularly under dry situations. In addition to direct damage to crops they also cause indirect damage by acting as vectors of important viral diseases. Some of the mites' harbour in carpets, sofa etc furniture in the houses and cause serious allergies in human beings. Some of the mites even cause loss to the stored produce. Not only they cause damage to crops they are also harmful to productive insects like honeybees acting as parasites. On the other side, some of the mites (predatory mites) are very useful in biological control of some insect pests and mites.

Phytophagous Mites

The mites that feed on plants are called phytophagous mites which mainly belong to families namely:
1. Eriophyidae (Erenium or gall or itch or rust mites).
2. Tetranychidae (spider mites).
3. Tenuipalpidae (Broad mites).
4. Tarsonemidae (False spider mites).

Mites as Vectors

Some of the eriophyid mites act as vectors of some important viral diseases.
Eg: *Aceria cajani* transmit redgram sterility mosaic disease.
Aceria tulipae transmit wheat streak mosaic disease.

Algae as a Renewable Source

Microalgae are a great resource which can be farmed without any complex facility. Local strains that are efficient producers of lipids, crude protein and neutraceuticals (nutritional supplements). The Algae Biotechnology Group aims to sustainably produce biodiesel, protein-rich animal feed and other high value products from microalgae. "Non-GM" approach to strain improvement, meaning we prefer not to genetically modify algae.

Mites as Parasites

Ecto Parasite on honey bee: *Tropilaelaps clariae*
Varroa jacobsoni

Endo Parasite: *Acarapis woodi* (Tarsonemidae).
(Tracheal mite on honey bee).
Locustacarus buchneri (Poapolidae) on bumble bees.

Predatoy Mites

(Phytoseiids)
Phytoseiulus persimilis.
Amblyseius fallacies.

House Dust Mite

Dermatophagoides farina

Stored Grain Mite

Acarus siro

Family: Tetranychidae (Spider Mites)

Body colour is red, green, yellow, brown etc. Body is 0.2-0.8 mm long. Body is flat, oval. Body is not divided into divisions and it is not segmented. Body of male tapers posteriorly Chelicerae are fused to form a stylopore and the movable segment of chelicerae forms a flagellate stylet. There is no mitotic division in larval stage. Most of the species are having narrow host range Palpal thumb claws are present.

e.g.,

1. Red spider mite on okra, cotton, citrus, tomato, grape, papaya, jasmine, pumpkin: *Tetranychus macfarlani* (telarius) results in Browning of leaves, fruits and hairy out growth on both.
2. Jowar mite (greyish green colour): Oligonychus indicus, lower side of leaf becomes wet, red spots appear in patches on leaf.
3. Vegetable mite, *Tetranychus cucurbitae.*

Family: Tenuipalpidae (False Spider Mites)

These mites are same as Tetranychidae, but without thumb claws. Three types of setae namely hysterosomal, dorsocentral and mediolateral are present. The true tarsal claw is hooked or pad like and with tenent hairs.

e.g.

1. Citrus flat mite: *Brevipalpus lewisi*.
2. Brevipalpus californicus - It causes serious injury to a wide variety of ornamental and agricultural crops.

Family: Tarsonemidae (Broad Mites)

Body is elliptical (ovoid). Body measures 0.1-0.3 mm long. Body is divided in to three parts Capitulum, Propodosoma and Prohysterosoma (the latter two parts together known as Idiosoma). Mouth parts are contained in a distinct capsular head known as Capitulum. Females are bigger than males. Body colour is opaque white, light green, pinkish adult integument is hard and shiny. Few hairs, spines are present on body. Chelicerae are needle like.

e.g.

1. Yellow mite on chilli- *Palyphagotarsonymus latus*
2. Paddy panicle mite - *Stenotarsonemus spinki.*

Family: Eriophyidae (Blister, Rust, Gall Mites)

Body is minute measuring 0.08 – 0.2 mm long. Body is 2 types: a) Elongate (vermiform), worm like, soft body and b) Wedge shaped, hard body. Body is segmented. Body is divided into cephalothorax and tapering abdomen.Abdomen is finely striated with long setae.Two pairs of legs on anterior end of body (in all the life stages) Pedipalpi or chelicerae are capable of making some independent movements and form a telescope or fold base. No thrusting stylopore. Egg, Protonymph (2 pairs of legs), Deuteronymph (2 pairs of legs) Adult (2 pairs of legs).

e.g.
1. Citrus rust mite- *Phyllocoptruta oleivora* (Pinkish brown blotches on fruits).
2. Jasmine mite- *Aceria jasmini*
3. Mango gall mite- *Aceria mangiferae*
4. Coconut mite- *Eriophyes guerreronis*.

Mites of Agricultural Importance

1. Jowar mite: *Oligonychus indicus*, Tetranychidae.
2. Red spider mite: *Tetranychus neocaledonicus*, & *T. telarius*, Tetranychidae.
3. Citrus rust mite: *Phyllocoptruta oleivora*, Eriophyidae.
4. Citrus leaf mite: *Eutetranychus banski*, Tetranychidae.
5. Sugarcane mite: *Schizotetranychus andropogonii*, Tetranychidae.
6. Coconut eriophyid mite: *Aceria guerreron*.
7. Jasmine mite (felt mite): *Aceria jasmini* – Eriophyidae.
8. Sweet potato rust mite: *Oxpleurites convolvuli* –Eriophyid.
9. Scarlet mite of tea: *Brevipalpus anstralis* – Tetranychidae.
10. Chilli mite: *Tarsonemus transluscens*
    Polyphagotarsonemus latus – Termipalpidae.
11. Sugarcane mite: *Tarsonemus spinipes*.
12. Coffee mites: *Oligonychus coffeae* –Tetranychidae.

Conclusion

Among arthropods, mites belong to the class arachnida which act as parasites, vectors, predators & also feeds on plants. They have specialised respiratory system & excretory system as other arthropods. They have generally sucking type of mouth parts. They are generally nonmotile & transported by means of phoresy. They have highly developed sensory system, nervous system & other systems as other arthropods.

Nano-Fertilizers a Technology to Increase Crop Production

Article ID: 35129

Prabhoo Singh[1], Anju Kanwar Khangarot[2]

[1]Assistant professor, Department of Soil Science, Bule Hora University, Ethiopia.
[2]Research Scholar, Department of Agronomy, Swami Keshwanand Rajasthan Agriculture University, Bikaner- 334006, Rajasthan, India.

Introduction

Recently the nano-fertilizers are getting importance in sustainable agriculture in increasing crop production, enhancing nutrient use efficiency and reduction in wastage of chemical fertilizers and cost of cultivation. The new developments on application of nano-fertilizer in agriculture, plant mineral nutrition, soil health, and interactions with soil microorganism directed to sustainable way by replacing conventional fertilizers with their nano-particulate counterparts possessing superior properties to overcome the current challenges of availability and uptake of nutrients, increasing crop yield and protecting the environment.

Nano-fertilizers are very effective tool for precise nutrient management in precision agriculture with matching the crop growth stage for nutrient and may provide nutrient throughout the crop growth period. Several studies showed that nano-particles of essential minerals and nonessential elements affected plant growth, physiology and development, depending on their size, composition, concentration, and mode of application, Nano-fertilizers provide more surface area for different metabolic reactions in the plant system which increase rate of photosynthesis and produce more dry matter and yield of the crop.

Nano-fertilizers are applied either to soil and / or leaves. Foliar application can be done during unfavorable soil and weather conditions. In addition to this, it promotes the direct entry of nutrients into the plant system, foliar application of nano fertilizer leads to higher nutrient use efficiency (NUE) and has given a rapid response to the growth of crops. Nano fertilizers are more reactive and can penetrate through cuticle, ensuring controlled release and targeted delivery. Hence, nanotechnology has a high potential for achieving sustainable agriculture, especially in developing countries (Naderi and Shahrak, 2013).

Nano-fertilizers and their Roles

Nano fertilizers enhance growth parameters (plant height, leaf area, number of leaves per plant) dry matter production, chlorophyll production, rate of the photosynthesis which result more production and translocation of photosynthesis to different parts of the plant as compare to traditional fertilizers (Singh *et al*. 2017).

Foliar feeding combination of N, P and K nano-fertilizer showed improvements of growth and yield parameters of wheat at lower concentration. Nano-fertilizers are easily absorbed by the epidermis of leaves and translocated to stems which facilitated the uptake of active molecules and enhanced growth and productivity of wheat. Nano-fertilizer have large surface area and particle size less than the pore size of leaves of the plant which can increase penetration into the plant tissues from applied surface and improve nutrient use efficiency and uptake of the nutrients.

Effect of Nano-Fertilizer on Seeds Germination and Crop Growth

Several researches reported that nano-fertilizers significantly influenced the seed germination and seedling growth which revealed the effect of nano-fertilizers on seed and seed vigor. Nano-fertilizers can easily penetrate into the seed and increase availability of nutrient to the growing seedling which result healthy and more shoot length and root length but if concentration is more than the optimum it may show inhibitory effects on the germination and seedling growth of the plant.

Application and Use of Nano-Fertilizer

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 (Hediat and Salama, 2012) at nano scale physical and chemical properties are differ than bulk material. Similarly, reported by Joseph and Morrison, 2006 that they rock phosphate if use as nano form it may increase availability of phosphorus to the plant because direct application of rock phosphate nanoparticles 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 increases phosphorus availability to the crop plants (Kannan *et al*., 2012).

Advantages of Nano-Fertilizers

Due to very less size of particles the nano-fertilizers have higher surface area which provide more site to facilitate different metabolic process in the plant system which results production of more photosynthets. Due to higher surface area and very less size they have high reactivity with other compound. They are highly soluble in water.

Particle's size of nano-fertilizers in less than 100 nm which facilitates more penetration of nano particles in to the plant from applied surface such as soil or leaves. Nano-fertilizer have large surface area and particle size less than the pore size of root and leaves of the plant which can increase penetration into the plant from applied surface and improve uptake and nutrient use efficiency of the nano-fertilizer.

Reduction of particle size results in increased specific surface area and number of particles per unit area of a fertilizer that provide more opportunity to contact of nano-fertilizers which leads to more penetration and uptake of the nutrient (Lin and Xing, 2007).

Nutritional Value

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 (Mahajan *et al*.,2013). Nano-Fe_2O_3 increase photosynthesis and growth of the peanut plant (Mahmoodzadeh, *et al*.,2013).

Important Benefits of Nano-Fertilizers Over Conventional Chemical Fertilizers

1. Their nutrient delivery system as they regulate the availability of nutrients in crops through slow/control release mechanisms. Such a slow delivery of nutrients is associated with the covering or cementing of nutrients with nanomaterials. By taking advantage of this slow nutrient delivery, growers can increase their crop growth because of consistently long-term delivery of nutrients to plants. For example, nutrients can be released over 40-50 days in a slow-release fashion rather than the 4-10 days by the conventional fertilizers.

2. In addition, nano-fertilizers required in small amount which reduce the cost of transportation and field application.

3. An additional major advantage is over accumulation of salt in soil can be minimized as it required in small amount.

4. Another advantage for using nano-fertilizers is that they can be synthesized according to the nutrient requirements of planned crops. In this regard, biosensors can be attached to a new innovative fertilizer that controls the delivery of the nutrients according to soil nutrient status, growth period of a crop or environmental conditions.

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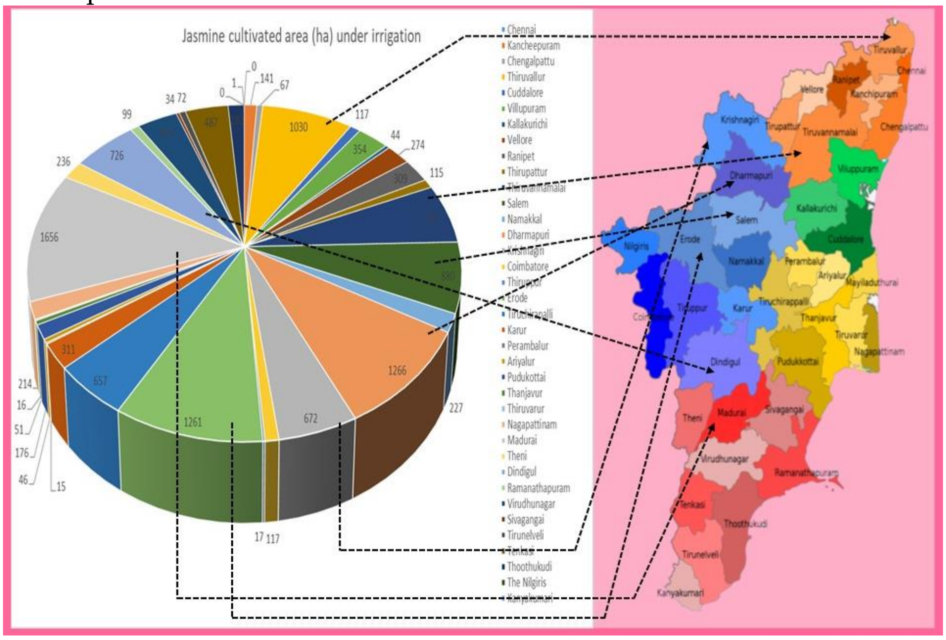
Jasmine Cultivation Technology in Tamil Nadu

Article ID: 35130

Umapathi Muniyappan[1], Harishankar Kanthaswamy[2]
[1]Dept. of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore-03.
[2]Dept. of Agricultural Economics, Tamil Nadu Agricultural University, Coimbatore-03.

Introduction

Jasmine is a fragrant flower that has been grown in India for centuries. Jasmine is an Arabic name that is said to have been originated from Yasmin. It was cultivated mainly for the bouquet, adorning women's hair, making garlands, religious offerings, and also widely used for the production of perfumes and cosmetics. Although India has 50 different jasmine species, only three of them are commercially grown namely, *Jasminum sambac* (Madurai Malli/Gundumalli), *Jasminum grandiflorum* (Jathimalli/Pitchi), and *Jasminum auriculatum* (Mullai). When compared to other states in India, Tamil Nadu cultivates a larger area under irrigated conditions and ranks first in jasmine production. The flowers were exported from Tamil Nadu to countries like Sri Lanka, Malaysia, Singapore, and the Middle East. Jasmine had a high demand in the markets during the festival seasons. Madurai, Dharmapuri, Thiruvallur, Salem, Dindigul Thiruvannamalai, and Krishnagiri regions are major jasmine cultivating areas in Tamil Nadu. Jasmine requires more manpower for harvesting, so the small farmers (less than 2 acres) are willing to cultivate the crop and it's an ideal crop for the small farmers.



Source: Season and Crop Report, Tamil Nadu, 2019-2020

Climate and Soil Requirement

The ideal climate condition for cultivating jasmine crops are warm summer and mild winter with moderate rainfall and sunny days. Jasminum sp. is usually cultivated in open field conditions for commercial production, but in some areas, they were cultivated in a protected environment with optimal soil pH (6.5-7.5) and temperature. It is grown in a variety of soil with rich organic matter ranging from well-drained clay soil to sandy loam soil. However, it gives the best yield when the soil is mixed with Farm Yard Manure (FMY) and also provides proper drainage.

Before planting, the main field should be ploughed one or two times to remove the weeds followed by digging pits at the size of 30×30×30 cm. Add 20 kg of FYM / pit before filling the pits. The best season for jasmine plantation is June-November with a spacing of 1.25 m x 1.25m is ideal. Layers or rooted cuttings are preferred for planting. Monsoon season is the ideal time for planting, it may remain up to 10-15 years in the field. Well-rooted, healthy, and strong two to three plants are planted in each pit.

Irrigation and Nutrition

Irrigation should be given immediately after planting. Thereafter irrigation at weekly or ten days interval may be given based on the soil and climatic condition. If it is the rainy season irrigation may not be required, but proper drainage should be ensured for growth. Manuring improves the vegetative growth and quantity of blooms. NPK (60:120:120 g/plant/year) is given along with FYM (10 kg/plant) in two equal split doses during November (after pruning) and June -July. Foliar spray of Zinc ($ZnSO_4$ @ 0.25%) and Magnesium ($MgSO_4$ @ 0.5%) should be given before flowering to increase the flower yield. For iron deficiency $FeSO_4$ (0.5%) spray may be given at fortnightly intervals until the chlorotic symptoms disappear.

Pruning and Weeding

Pruning is an important cultivation practice followed in jasmine cultivation because jasmine has terminal and axillary flowering habits thereby increasing the shoot numbers which ultimately increases the flower yield. The plant was pruned up to 45-50 cm from the ground level during the last week of November (Fig.1). Mostly manual hand weeding is followed but it was quite expensive, so chemical (glyphosate-based herbicide and glufosinate-ammonium-13.5 %) weed control is effective and economical.

Fig.1. Pruned plant

Plant Protection from Pest

Pest attack causes severe damage in jasmine production. Due to the occurrence of drought and hot weather, the incidence of pests like budworm, leaf webber, and red mites are more.

1. Budworm (*Hendecasis duplifascialis*): Budworm causes serious injury to emerging buds of jasmine (*J. sambac*). The larvae feed on buds inside the bud or flower cluster. It feeds on the closed bud's innermost petals in the early stages and then emerges from a circular hole in the tubular portion of the corolla to tunnel into additional buds on the same plant, finally pupating in the earth. Inside an infected flower cluster, the larvae create silk and excreta tunnels, as a result, the flower buds may fall off and turn reddish (Fig. 2), impeding flower opening.

Fig.2. Infected flower buds

Control measures:

i. Spraying of Spirotetramat (Movento OD) 1 mL/L or Spirotetramat 11.01 + Imidacloprid 11.01% ww SC (Movento energy) 1 mL/L
ii. Spray Profenophos (Curacron) 50% EC @ 2 mL/L
iii. Spray neem seed kernel extract 5 %

2. Leaf webber (*Nausinoe geometralis*): The caterpillar causes a complex network of leaf webbing, particularly in the lowest region of the plant, causing serious damage**.** The caterpillar feeds by removing chlorophyll from the leaves. During rainy days, the lower foliage becomes infected more, while in dry and sunny weather the infestation is more severe in terminal shoots.

Control measures:

i. Spray Imidacloprid (Confidor 50mg) 2 to 5 g/Lit
ii. Spray Cyfluthrin + Imidacloprid (Solomon 300 OD) 2 mL/lit
iii. Acetamiprid 20P @ 80 g ai. /Ha or neem oil @ 3 ml/l of water
iv. Yellow-orange sticky traps @ 5/acre can be used to monitor whether thrips populations are rising or falling
v. Green lacewings, Scymnus, and *Chrysoperla oculate*- predators may use to control an insect population.

Red Spider Mite (*Steneotarsonemus pallidus*): The occurrence of red spider mites is high under hot and dry circumstances, especially in the summer. The mites feed on the undersides of the leaves which become yellow and fall off.

Control measures:

i. Spray Spiromesifen (Oberon-240 SC 22.9 %W/W) 2 mL/L
ii. Thimet (Phorate 10% G) 2g/l should be given
iii. Spraying of Quinalphos (Ekalux 25 % EC) 2 mL/L.

Harvesting

After two years of planting, jasmine starts flowering and gives a standard yield up to 10 years, thereafter the plants get old and the output declines. Mostly unopened, fully developed flowers buds are economically valuable and these flower buds are harvested early in the morning before 11 AM. Despite the fact that fully opened, the flowers are utilized to extract concrete.

Fig. 3. Flower bud harvesting

Yield

Flower yield up to 700-8000 kg/ha.

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Biofortification and its Advantages

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N Sushma[1], T Kamalaja[2]
[1]P.G scholar, Department of Foods and Nutrition, Post Graduate and Research Centre, PJTSAU, Rajendranagar, Hyderabad, Telangana, India.
[2]Senior Scientist, AICRP-Home Science, Department of Foods and Nutrition, Post Graduate and Research Centre, PJTSAU, Rajendranagar, Hyderabad, Telangana, India.

Introduction

The practise of consciously increasing the content of an important micronutrient in a food, such as vitamins and minerals (including trace elements), in order to improve the nutritional quality of the food supply and provide a public health benefit with minimal risk to health is known as fortification. The process of improving the nutritional quality of food crops through agronomic practises, traditional plant breeding, and modern biotechnology is known as biofortification. Biofortification differs from conventional fortification in that it tries to boost nutrient levels in crops during plant growth rather than using manual methods during crop processing. As a result, biofortification may offer a way to reach populations where supplementation and traditional fortification activities are difficult or impossible to implement. Through mineral fertilization, conventional breeding, or transgenic techniques, biofortification improves the nutritional value of the edible sections of plants. It's also known as the process of enhancing the bioavailable concentrations of an element in edible parts of agricultural plants by agronomic or genetic approaches.

Examples of Biofortification Schemes Include

1. Biofortification of iron in rice, beans, sweet potato, cassava, and legumes.
2. Biofortification of zinc in wheat, rice, beans, sweet potato, and maize.
3. Biofortification of provitamin A carotenoid in sweet potato, maize, and cassava.
4. Biofortification of amino acids and proteins in sorghum and cassava.

Methods of Biofortification

Agronomical Biofortification: Agronomic procedures such as fertilizer treatment to increase zinc and selenium levels in plants cultivated in soils deficient in such minerals.

Conventional Plant Breeding: Traditional breeding methods can be used to generate biofortified crops if crop populations have enough genetic variety for the desired feature, such as high beta-carotene concentration. Harvest plus is the most comprehensive, methodical, and symbolic programme of biofortification through conventional breeding. Increased levels of three minerals (iron, zinc, and provitamin A) in seven main crops, including beans, cassava, maize, rice, wheat, sweet potato, and pearl millet.

Genetic Modifications

In the industry can be distributed into two distinct groups:
Agronomic modifications: Its objective is to help the plant grow better. Herbicide-resistant soy beans and pest-resistant maize are the most frequent GM food crops.

Nutritional modifications: Aim to improve the nutritional profiles of crops. They add nutrients totally, absent from all varieties of a plant, or present only in small amount. In such cases improving nutrient profiles through conventional breeding is not possible.

Advantages of Bio-Fortification

1. The biofortification approach seeks to take advantage of the constant daily consumption of large amounts of food staples by all family members, including women and children who are most at risk for micronutrient malnutrition. This method implicitly targets low-income households due to the importance of dietary staples in the diets of the poor.

2. After the one-time asset is made to develop seeds that fortify themselves, persistent costs are low and germplasm may be shared globally. Plant breeding is cost-effective because of the multiplier effect it has across time and distance.

3. Once in place, the biofortified crop system is highly maintainable. Even if government focus and international financing for micronutrient issues disappear, nutritionally improved cultivars will continue to be grown and consumed year after year.

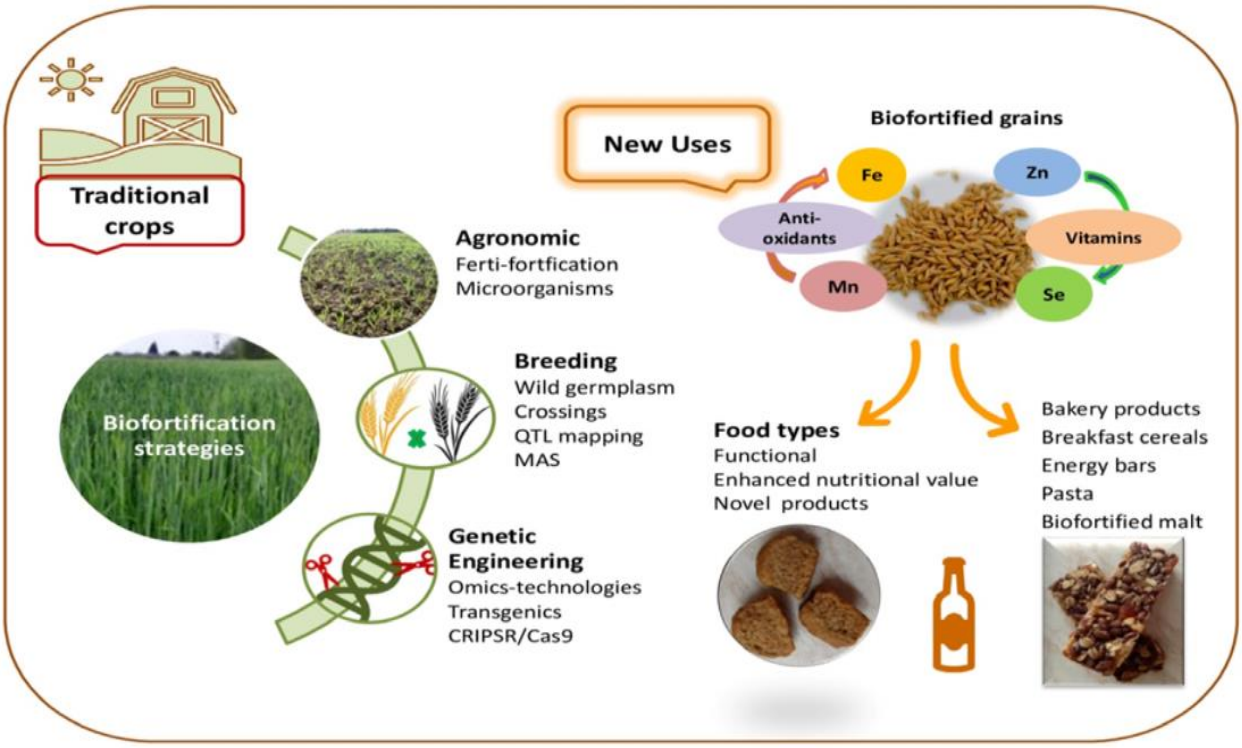
4. Moreover, biofortification provides a truly possible means of reaching malnourished populations in relatively remote rural areas, delivering naturally fortified foods to people with limited access to commercially marketed fortified foods, which are readily accessible in urban areas.

5. Biofortification and commercial fortification thus, they are highly complementary. Breeding for higher trace mineral density in seeds will not sustain a yield penalty.

6. Biofortification may, in fact, have major spill over effects in terms of enhancing farm output in developing nations while also being environmentally friendly.

7. Mineral-rich seeds sell themselves to farmers because, according to recent research, seeds rich in trace elements are better able to withstand biotic and abiotic pressures such as illnesses and environmental stresses. (Bouis 2003).

8. Additionally, fortified or enriched seeds have higher plant vigour, seedling survival, initial emergence speed, and grain output.



Future Challenges

1. Produce crops with a higher iron content for human consumption. Biofortification techniques other than phytic acid or polyphenol reduction should be assessed further in order to increase iron absorption without loss of their beneficial effects.

2. Detailed knowledge on mechanisms regulating iron compartmentalization in various plant organs will offer a major contribution for reaching such goal.

3. Expand research on prebiotics and iron absorption. Crops supplemented with prebiotics have the ability to partially overcome the "iron conundrum" generated by host–pathogen iron competition by promoting gut health and gut-associated immune protection.

4. Encourage large-scale prospective studies on the benefits of iron biofortified crops on the success of the biofortification method in treating iron deficiency anaemia and increasing overall health.

5. Increase the efficiency with which minerals are absorbed from the soil into the plant's roots. Increase the ability of storage tissues to store minerals in a way that does not interfere with plant vegetative growth and development while being bioavailable to people.
Lower levels of antinutritional substances such phytic acid, which inhibit mineral absorption in the stomach.

Conclusion

Micronutrient malnutrition is estimated to affect more than half of the world's population, making it one of humanity's most critical global concerns. Micronutrient malnutrition, sometimes known as "hidden hunger," is quite common among mothers and preschool children, and is caused mostly by a lack of micronutrients in the diet, particularly zinc and iron. Biofortification or raising the bioavailable concentrations of critical elements in edible parts of agricultural plants through agronomic intervention or genetic selection, could be a solution to malnutrition or hidden hunger reduction.

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Potentiality of Underutilized Crop: *Dioscorea bulbifera*

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Bhadke T. G.[1]

[1]Ph. D Scholar, Department of Horticulture, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri- 413722 Maharashtra.

Introduction

Dioscorea bulbifera is a tribal plant, which belongs to the family Dioscoreaceae assigned to the order dioscorales. It is found throughout India particularly in warmer places and is known as Yam or Air potato. It is a climber plant with tuberous root. *Dioscorea bulbifera* is a large genus of annual twinning herbs, distributed throughout the moist tropics of the world which extends into warm temperate regions. In India it is known as Gonth, Kolkand, Varaheekand, Mataru. The tuber is edible when either boiled or cooked.

Health Benefits of Air Potato

Some of the well-known health benefits of air potato are given below:

1. Anti-inflammatory qualities: Air potato has been found to have anti-inflammatory activity. This can be very helpful for different conditions like swelling caused by injuries as well as arthritis.

2. Good for digestive system: Consuming air potato can help improve or keep digestive system healthy and away from some common digestive disorders. It should be helpful in regulating your stool movement thus avoiding conditions like constipation and diarrhoea.

3. Skin disorders: Powdered form of air potato has been traditionally used for treating different skin conditions.

4. Treat different eye disorders: Air potato has been consumed to help cure or prevent different kinds of eye ailments like conjunctivitis. Conjunctivitis or pink eye is the inflammation of the outermost layer of the white part of eye as well as the inner surface of eyelids.

5. Contains antioxidants: Air potato is rich in flavonoids and isoflavonoids which can be sources of antioxidants.

6. Treat respiratory disorders: Air potato has been used to treat or cure some respiratory disorders. It is good for treating asthma, coughs, and tonsillitis.

7. Good for heart: Eating air potato that can lead to a healthier heart. It can able to decrease blood cholesterol levels. Another thing is that it is also able to help regulate blood pressure. Normal levels of cholesterol and blood pressure can both help in keeping heart healthy and reducing the risk of different kinds of heart diseases.

Conclusion

In order to mitigate the food requirement of growing global population. The technologies focused on fewer crops leading to negligence of several important crops; popularly known as underutilized or neglected crops. In the list of underutilized crops, air potato occupies significant niche as it is rich in several phytochemicals and could be grown under multiple stress conditions. Air potato contains flavonoids, saponin and terpenoids in addition to its higher contents of basic essential nutrients such as protein, carbohydrates, vitamins, minerals *etc*. *Dioscorea bulbifera* will not only turn the underutilized crop into valuable crop for the generation next population, but it will also step towards crop diversification for the benefit of the global agriculture.

Hydrogel: Super Absorbent Polymer in Horticulture

Article ID: 35133

Kavana G. B[1], Thejashree C.M[2]
[1]PhD Scholar, Department of Floriculture Landscape Architecture, College of Horticulture, Bengaluru, Karnataka.
[2]M. Sc in Horticulture, Dept. of Fruit science, IGKV, College of Agriculture, Krishak nagar, Raipur, Chhattisgarh.

Introduction

21st century has witnessed a steady decline of irrigation water potential conjugated with the ever-growing global population & enhanced economic activities among countries specially located in arid and semi-arid regions of the world. As these regions are ever facing water crisis due to uncertain and inadequate natural precipitation, the problem with water scarcity may possibly aggravate further. Global survey shows, the worst affected areas would be the semi-arid regions of Asia (India), the Middle-East and Sub-Saharan Africa, all of which already face issues with heavy population growth and majority of them below the poverty line.

It is estimated by 2025 water scarcity will be a major issue in India requiring immediate redressal. As per the Central Water Commission, the demand for water is growing at a steady rate but the availability of clean water in future is declining even faster. In the Indian scenario, Agricultural irrigation practices seem to be responsible for consumption of 80% of the available potable water. There is an increasing trend to this with the further intensification of agro based industries. Due to the large geographical dimensions of the sub-continent and varied soil and farming practices, modern irrigation practices can still only cater to 40% of the grown crops. The remaining areas are far more susceptible to improper practices thus greatly lowering the effective and judicious use of available water for crops.

Major Drawbacks with Irrigation Practices

The predominant irrigation practice is surface draining *i.e.,* direct application of water to crops from surface. It's a problematic and flawed system as the crops can utilize only 50% of the provided water while the remaining is lost in conveyance, as runoff and by evaporation. Modern methods like drip irrigation and use of sprinklers can effectively reduce the wastage of irrigation water but high initial costs, inadequate government subsidy and cooperation, lack of technical input and after sales service, faulty equipment, damage due to pests and high costs of spares prohibits the farmers from opting these techniques.

It is worth mentioning that 98 million of the total 120 million farm holdings are small and marginal farmers, thus, net income from small farms makes farmers reluctant to adopt such water management practices in agriculture. Spatial diversification in soil characteristics, shortage of large land holdings and underprivileged conditions discourage farmers from adopting advantageous and economical application of water conserving irrigation techniques, even in arid zones with distinct scarcity of water. The stress on sustainable development practices even in the agricultural sector has laid emphasis on further judicious, economic and optimum utilization of land, water and plant resources with the major goal to maximize land and water productivity without threatening the environment and available natural resources.

Super Absorbent Polymers (SAPs)

Extensive research all over the world, particularly Iran, China, Europe and USA has led to the development of a particular class of Super Absorbent Polymers that can increase water use efficiency and enhance crop yield. Soil conditioning with SAP is an interesting and innovative facet in the field of modern agriculture as well as rain-fed agriculture. It was shown that SAP materials are hydrophilic networks that can absorb and retain large amounts of water or aqueous solutions. Their uptake can be as high as 100,000% and even more. SAPs are in general, small sugar like hygroscopic crystals that can be directly added to cultivation soils. They are predominantly used for improving irrigation efficiency; smart delivery materials that can help combat plant pathogens even with lower pesticide dosage, reducing the quantity of soluble NPK fertilizers per crop cycle thus greatly contributing to water and environmental conservancy practices.

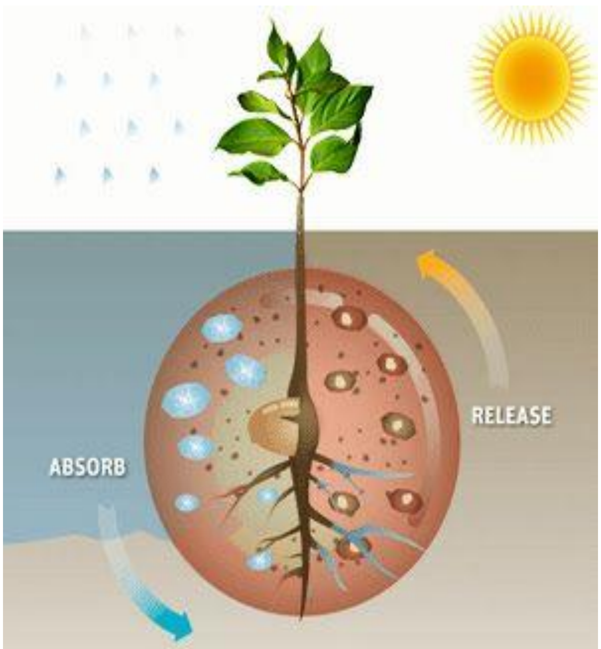
Hydrogel

The Hydrogel polymer is inert materials affect physical characters of soil such as water holding capacity, soil aggregate, soil permeability, also, affect soil density, structure, texture, and release water through the soils.

The hydrogel polymer is a soil conditioner able to retain water and nutrients, and releases back to the plants when surrounding soil near the root zone of plants starts to dry up. These materials improve water-use efficiency, and extend irrigation intervals, increase soil's water-holding capacity up to 2 to 4 times and soil porosity, also, provide proper conditions in root zone through supply water and nutrients for plant, improving plant viability, improve root development and ventilation, also, improving the growth of seedlings, and reduce irrigation water quantities, so, prolong irrigation intervals.

Hydrogel Polymer

Water management is one of the most important challenges facing world, particularly in arid regions suffer from a severe shortage of freshwater resources, so, the use of the available materials and techniques like Hydrogel polymer to maximize water use efficiency and increase crop productivity have more attention during the current and coming decades. Hydrogel polymers used in different fields like health products, cement industry, pharmaceutical production, and agricultural sector. Hydrogel polymers play an imperative role in the agricultural sector, it's use as a soil conditioner for providing a proper climate around the plant when soil near the root zone starts to dry up, improving irrigation water efficiency, and extend irrigation intervals.



The hydrogel polymer has high capacity to absorb large quantities of water and keep it for a long period under drought conditions, polymer could absorb and preserve quantity of water many folds of their weight, it reduces water loss and increase irrigation intervals, also, polymers implement some soil physical properties. There are various applications of hydrogel polymer in agricultural sector *i.e.*, water reserve, seed coating, reduce soil erosion, food additives, tissue culture, as structural materials (produce mulches). hydrogel application may be a proper technique to increase water and fertilizers use efficiencies in arid regions.

Hydrogel Polymer and Agriculture Polymer application is a very significant issue in both research and applicable fields due to their applications in different fields like pharmacy products, cement industry, and agriculture. In the agricultural sector polymer play an important role, the polymer used for different purpose as soil conditioners in sandy soil, seed coating, carriers for slow-release fertilizers, and carrier for pesticides and herbicides. Polymer mixing into soil before cultivation or in a circle around the tree before the beginning of the growing season, in some cases, could be sprayed on the soil surface before planting seeds.

Advantages of Hydrogel Polymer in Agriculture

Hydrogel polymers have been widely used globally over the past two decades in the agricultural sector for many reasons:

a. Improve growth and crop productivity of Navel orange sandy soil conditions, increase total yield of wheat, improving the growth of palm trees, particularly in sandy soil.
b. Increasing seedling survive ratio, enhancing root growth under stress conditions.
c. Increase water-use efficiency and provide a regular supply of water and nutrients to plants,
d. Increase the soil's ability to reserve irrigation water for as long as possible, reduce soil erosion and reduces desertification of agricultural lands and contribute to sustainable agricultural.
e. Improve nutrients efficiency, provide water and nutrients for the plant during the dried period, and improve the nutritional status of the plant.
f. Reduce the fertilizers loss by leaching, and protect environmental by reducing soil and water pollution.

Effect of Hydrogel Polymer on Soil Polymers application improving soil properties as follows:

a. Increasing the soil holding capacity.
b. Increasing the efficiency of irrigation water use, reducing the quantities of irrigation water, prolonging irrigation intervals, so, reducing irrigation costs.
c. Increase the field capacity of light soils for a long time.
d. Improving the permeability of heavy soils as a result of reducing the fusion of granules.
e. Reduce soil erosion.

Important Precautions During Using Polymers in Fruiting Orchards

Polymer applies in a circle around the tree to avoid damage part of the root system and must cover to protect from sun heat.

1. Avoid adding polymer to dry soil, polymer need a proper percentage of moisture before the addition.
2. Irrigation directly after application to activate the polymer.
3. Deciduous trees orchard: preferable, polymers application during the dormancy period.
4. Field crop and Vegetables: polymer applies before cultivation and mixed with soil and covered after addition to avoiding the negative impact of weather conditions.

Conclusion

In the agricultural sector the main usage of polymers as soil conditioner due to their high-water holding capacity under subsequent wetting and drying cycles, also, polymer increase water use efficiency, improve soil characters, decrease soil erosion and reduce desertification, and improve vegetative growth and fruit yield of different crops particularly in arid and semi-arid regions such as the Arab region which suffer from water shortage. This positive influence due to improving water availability, increasing the availability of nutrient supply, and implement the efficiency of macro-nutrients. The use of polymers in different crops like date palm cultivations, Navel orange orchards and different field crop has a promise effect on growth and productivity of various crops.

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Sub-Mission on Agricultural Mechanization

Article ID: 35134

Vavilala Priyanka[1]

[1]Ph.d scholar, Department of Agricultural extension and communication, College of Agricultures, Sardar Vallabhbhai Patel University of Agriculture and Technology, Modipuram, Meerut, Uttar Pradesh, 250110.

Introduction

The area of agricultural land in the world has limits, but the demand for food keeps increasing due to population growth. Raising productivity on limited land to meet the increasing demand resulting from population growth, as well as high incomes is a very important task. The task is of greater importance to India than to the rest of the world, given that India accounts for 2.4% of the world's land area and 4% of its water resources, but must support 17% of the world's population and 15% of the livestock population. To increase productivity, fast and precise fieldwork is required. To make this possible, agricultural machinery plays an important role.

The Ministry of Agriculture and Farmers Welfare launched a Sub-mission on Agricultural Mechanization (SMAM) in 2014-2015 with the aim of expanding agricultural mechanization to small and marginal farmers and areas/regions where the availability of agricultural energy is low. To boost mechanization in the agricultural sector, improved agricultural tools and machinery are essential inputs of modern agriculture that improve crop productivity as well as reduce human fatigue and the cost of farming. Mechanization also helps to improve the efficiency of the use of other inputs, which is why it is considered to be one of the most important sectors of the agricultural sector to boost farmers' incomes and growth of the agricultural economy. In order to promote agricultural mechanization in the country and achieve greater inclusiveness.

Among states, the availability of agricultural energy in Punjab, Haryana, western Uttar Pradesh and western Rajasthan is above the national average of 2.02 kWh / ha. In the rest of the country, especially in the eastern and northeastern regions, there is a great need to promote agricultural mechanization as a special task. The program will be implemented in all states, to promote the use of agricultural mechanization and increase the ratio of agricultural energy per unit of arable area to 2.5 kW / ha. SMAM will have central sector programs to which the Indian government will contribute 100%. Centrally sponsored schemes are covered by administrative and flexible funds in which the Indian government contributes 60% and the states 40%, with the exception of the northeastern states and the Himalayan states where it is 90% (central participation) and 10% (state participation). For Union territories, this is a basic quota of 100%.

Mission Objectives

The objectives of the mission are as follows:
1. Extension of agricultural mechanization to small and marginal farmers and to areas where the availability of agricultural energy is low
2. Strengthen “Custom hirimg centers” to counter negative economies of scale due to small land ownership and the high cost of individual ownership;
3. Establishment of agricultural equipment hubs of high technology and high value
4. Sensitization of stakeholders through demonstration and capacity building activities;
5. Provide performance testing and certification at designated test centers located across the country.

Mission Strategies

To achieve the afore mentioned objectives, the mission will adopt the following strategies:
1. Carry out performance tests of various agricultural machinery and equipment in the four Farm Machinery Testing and Training Institutes (FMTTI), Designated State Agricultural Universities (SAU) and ICAR Institutes;
2. Promote agricultural mechanization among stakeholders through training and demonstrations on the field and off the field.
3. Provide financial assistance to farmers to purchase agricultural machinery and implements.
4. Establishment of custom hiring centers and crop/location specific machinery/implements for crops.
5. Provide financial assistance to small and marginal farmers for the rental of machines and tools in areas that lack machines.

Mission Components

1. Promotion and strengthening of agricultural mechanization through training, testing and demonstrations: Aims to ensure performance testing of agricultural machinery and equipment, develop the capacity of farmers and end users, and improve agricultural mechanization through demonstrations.

2. Demonstration, training, distribution of Post-Harvest Technology and Management (PHTM): Aims to popularize technology for primary processing, value-added, low-cost scientific storage / transportation, and by-product handling through demonstrations, capacity building of farmers and end users. Provide financial assistance to establish PHT units.

3. Financial aid for the purchase of agricultural machinery and equipment: There is an incentive to own various agricultural machinery and equipment according to the aid criteria.

4. Establishment of banks dedicated to the custom hiring of agricultural machinery: Provide adequate financial assistance to establish banks of agricultural machinery dedicated to the leasing of suitable sites and crops.

5. Establishment of high-tech and productivity equipment for custom hiring: Provides financial assistance for the establishment of high-tech machinery hubs for high-value crops such as sugar cane, cotton, etc.

6. Promotion of agricultural mechanization in selected villages: Provides financial assistance to promote appropriate technologies and establish agricultural machinery banks in selected villages in the states.

7. Financial assistance for the promotion of mechanized operations / hectare carried out through custom hiring centers: Financial assistance per hectare is provided to beneficiaries who rent machinery / equipment from custom hiring centers in areas without machinery.

8. Promotion of farm machinery and equipment in the Northeast region: Provides financial assistance to beneficiaries in the Northeast states with high potential but not highly automated.

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Improve a Storage Structure to Keep Grains Safe for Future Purpose

Article ID: 35135

Anamita Sen[1]
[1]Ph.D scholar, Plant Pathology, PG College of Agriculture, Dr. RPCAU, PUSA, Bihar.

Introduction

According to World Bank Report, post-harvest losses in India amount to 12 to 16 million metric tons of food grains each year, an amount that the World Bank stipulates could feed one-third of India's poor. It is estimated that in tropical countries approximately 25-40 % of the food grains produced is lost because of inadequate storage facilities. Losses during storage may be either qualitative or quantitative. Losses in weight due to feeding of rodents, spillage during loading and unloading may be attributed to quantitative losses and loss in aroma, during milling, in cooking quality, or due to fungal infections may be attributed to qualitative loss. There are three agencies engaged mainly in large scale storage/warehousing capacity, namely FCI, CWCs and SWCs. Over a period of time scientific storage/ warehousing capacity is being developed by these public agencies and they are planning to increase it further.

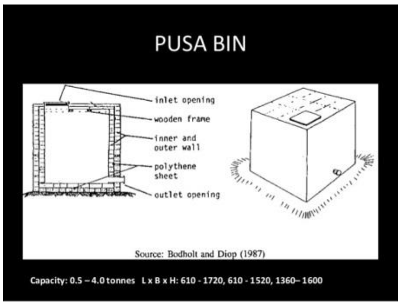
An Ideal Storage Structure should have Following Qualities to Minimize the Losses

1. Structure should be elevated and away from moist places.
2. Structure should be air tight, even at loading and unloading portion.
3. Structure should be rodent proof and clean.
4. Structure should be plastered to avoid termite attack or attack by other insects.
5. The storage room may be sealed with tarpaulin and treated with fumigants whenever needed.

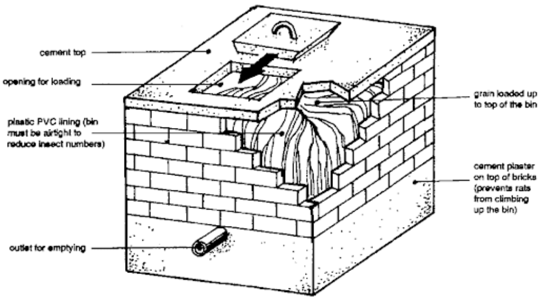
Scientific Storage of Food Grains

1. Improved Storage Structures: In this type of storage structures there are some improvements made in traditional storage structures. Improved type of storage structures having capacities is generally 1.5 to 150 tonnes. The storage of grain is generally done in one of the following storage structures in the different rural and urban regions of India in bulk, bag as well as bag and bulk storage.

a. Pusa bin: Pusa bin is a storage structure made up of mud. To make the storage structure moisture proof a plastic film is used in all the inner sides of the bin. On this platform, a sheet of 700-gauge plastic is spread in such a way that it overlaps the platform on all sides by atleast 6 cm. On the plastic sheet, a layer of 7 cm thick kachcha bricks is then laid. The upper roof of the structure is made of burnt bricks. For unloading of grains, an inclined wooden or steel pipe is fixed in such a way that grains may come out of structure by gravity. The mouth of pipe is closed by a cover. The inside of all the four walls and roofs are covered with a plastic sheet. On the top, an open of about 50 cm×50cm is left for loading of grains. Leaving this open space, the roof is sealed by mud. After the bin is filled with grains, the top open space is well covered by a plastic sheet so that air may not enter the bin.



b. Brick and cement bin: These types of storage structures are very strong and effect of seasons on these is minimum. These structures are very strong and therefore the effect of season on them is negligible. The bin is made on a platform raised at 60 cm above the ground. A ladder is provided on one side of bin for loading the material i.e., grains. A whole of about 60 cm diameter is provided on the roof for the purpose of loading the material i.e., grains. The walls of bin are about 23 cm thick with cement plastered on both the sides. Roof is made of R.C.C. The base of bin is made inclined and an outlet is provided for unloading the grains. The capacity of such bin is usually between 1.5 -60 tones. For cleaning of bin and complete unloading, a provision of iron rings steps is provided inside the bin for person can enter and exit the bin.



c. Bunker storage: This type of storage structure is used for long term storage and larger volume of grains storage. Bunker storage structure is used for long term storage of a larger volume of grains. The structure is successful as means of storing grains safely, securely and economically. By controlling insects and the moisture, the losses in stored grains can be reduced up to 0.5%. A drain is also provided for drainage of rain water.

d. CAP (Cover and Plinth) storage structures: The word CAP is used for cover and Plinth. Plinth from the bottom and cover from the top. This type of open storage is considered as transit storage and serves the purpose of storage of food grains in bags for short period. The CAP is used for cover and plinth storage. This type of open storage is considered as intermediate storage and serves the purpose of storage of food grains in bags for short period. This type of storage facility is cheaper as compared to conventional bag storage godowns. The cover is rectangular in shape having five sides and made from polythene film of 1000 gauge, leaving the bottom side open. The cover is used for protecting stack of bags. Normally the stack is built over a space of 9.11× 6.1 m with a height of 18 bags which gives the storage capacity of around 150 tones. The cover having a dimension of 9.4 m× 6.4 m × 5.5m.

2. Modern Storage Structures: In India, for larger volume of food grains are to be stored in bulk is 'silo' and conventional god owns (Shed) designed for bagged storage. Silos are constructed from steel or reinforced concrete. There are a cluster of adjoining silos in any modern large/ capacity processing plant. The modern permanent storage system should be selected for the safe keeping of stored grains and other products. Silos/bins are classified into two groups depending upon the relative dimensions of the container. These are classified as (1) deep bins and (2) shallow bins.

Steps Necessary for Good Storage Practice in Respect of all Food Grains

1. Before storage:

a. Checking for leakage of rain water and sufficiency of drainage facilities.
b. Assessment of capacity of the facility
c. Pesticidal treatment
d. Cleanliness of the area.
f. Repairs to available equipment.

2. After receipt of seed:
a. Inspection for variety.
b. Inspection carefully for infestation, it any, and when present, for type and extent of infestation.
c. Inspection whether grain has excess moisture
d. Any grain rendered wet or damaged to be segregated and salvaged with facilities available and check the weight received.

3. During storage:
a. Maintenance of cleanliness.
b. Ensuring aeration where necessary.
c. Checking for leakage after rains.
d. Inspection for insects, rats and mites at fortnightly intervals.
e. Watch for advancement in deterioration, if any.
f. Pesticidal treatments necessarily based on observations.

Conclusion

The grain production has been on the rise with better facilities in terms of seeds, technology, fertilizers, pesticides and irrigation but associated is the loss of grains which has also increased. Natural contamination of food grains is greatly influenced by environmental factors such as type of storage structure, temperature, pH, moisture, etc. However indigenous storage structures are not suitable for storing grains for very long periods. Here in lies the significance of improved storage structures and scientific storage of grains in form of warehouses. These provide safe and economical means of grain storage for long durations. Need of the hour is to strengthen traditional means of storage with modern inputs and to provide cheaper storage to farmers so as prevent enormous storage losses.

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Madur Kathi: A Traditional Crop with Rural Socio-Economic Prospects

Article ID: 35136

Saikat Biswas[1], Rupa Das[2]
[1]Department of Agronomy, [2]Department of Seed Science and Technology,
Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India-741252.

Introduction

With the population growth as well as agricultural land shrinkage and mechanization, agricultural sector is currently facing under-employment. In this context, a large section of the people of rural areas, specially, in swampy, marshy and wetland areas, rely only on lesser-known wetland crops for their livelihood. Mat sedge (*Madur kathi*) is one such traditional and lesser highlighted wetland crop which is grown for making mats or various other value-added products. Mat weaving is a popular and traditional practice which has developed into handicraft industry in rural areas. Mat making is a long tradition of poor rural people with positive socio-economic impact.

Distribution and Edapho-Climatic Requirements

Madur kathi or mat sedge (*Cyperus* sp.), a robust, aquatic sedge belonging to the family cyperaceae with height of 1.5-2 m arising from creeping woody rhizome, grows well in wet, swampy, marshy areas of tropics and subtropics. It protects the banks of rivers from erosion. Mat sedge is habitant of India, China, Japan, Sri Lanka, Thailand, Malaysia, Nepal, Bangladesh, Java, Sumatra etc. In India, it is mostly found in eastern and southern parts up to an elevation of 2000 m. West Bengal, Kerala, Tamil Nadu, Andhra Pradesh etc are the major states associated with commercial production of mat sedge. In West Bengal, it is grown in West Midnapore (Sabong, Pingla and Narayangarh blocks etc.), North 24 Parganas (Habra, Nagar Ukhra, Gaighata etc.), East Midnapore (Bhagabanpur: hub of mat sedge weaving), North Bengal (Coochbehar, Dinhata etc). Mat (*Madur*) produced from Sabong has been conferred President's Award due to its popularity and fine quality. Due to presence of rivers and tributaries, vast areas of Sabong is water logged and thereby, produces bulk quantity of mat sedge (*madur kathi*).

Madur kathi is native of South East Asia (tropics to subtropics, humid to sub-humid conditions) and can be grown throughout the year in three seasons. However, *madur kathi* in *kharif* season shows greater growth and productivity than another season. On the other hand, *madur kathi* in winter season shows slow growth due to low temperature. Ratooning can also be done for 5-6 years and with suitable package of practices, for 10-12 years. *Madur kathi* mostly prefers low-lying water-logged areas. However, *Cyperus jeminicus* is grown in dry sandy pasture areas near the sea of Sri Lanka, Abyssinia and Central Africa. *Cyperus nivens* grows in shady moist pasture area. Generally, clay and clay loam soil with poor drainage, swampy areas with standing water of 20-30 cm are mostly preferred by mat sedge. Sometimes drainage of water in *kharif* season is required as excessive water (> 50cm) can cause quality deterioration. On a contrary, during dry months, irrigations need to be provided for mat sedge cultivation.

Species

1. *Cyperus irria* Linn. (*Bura Chuka* in Bangladesh)
2. *C. tegetum* or *C. tegetiformis* Roxb. (*Madur kathi* in West Bengal)
3. *C. corymbosus* Rottb. (*Madur kathi* in Tinnevelly area of Tamil Nadu)
4. *C. articulates* L.
5. *C. malaccensis* Lam.

C. tegetum is synonymous with *C. pangorei* (silk mats of Pathamadai, Tamil Nadu), *C. dehiscens, Papyrus pangorei* and *Papyrus dehiscens* (Tamil Nadu, Andhra Pradesh, Kolkata of West Bengal, Killimangalam and Palghat of Kerala). Mats produced from *C. corymbosus* (Tinnevelly and Palghat of Kerala and some pockets of West Bengal) are fine and expensive with high aesthetic beauty. Mats of Tennevelly area are uncoloured or 1-2 bands of red and black colour at each end (Flexible enough for rolling in to like a walking stick). Calcutta mats (from West Bengal) are plain white coloured or with painted borders and they are produced from *C. tegetum* (Sabong, Maina of Midnapore, Gaighata, Nagar Ukhra, Habra of North 24 Pargansa, Cooch behar, Dinhata of North Bengal).

History of Mat Weaving

Mat (*Madur*) is a renowned old cottage industry in India. There are references of *Madur* in Atharvaveda, Satapatha Brahmana, Mahabharata and many other sacred literatures of Sanskrit language (Jana and Puste, 2014a). In West Bengal, mat weaving dated back to Muslim period (Masland mat). In the time of Jaigirdari system, Nawab Alibardi Khan issued order to Jaigirdars for compulsory supply of masland mats and eventually, markets for mats in Midnapore were formed. In Muslim period, two important centres of masland mats were Kasijora and Narajol. During British period, mat markets further grew and in 1907-08, around 4,48,300 mats were reported to be woven. Since ancient times, mats are being woven generally by the *Mahishya* cast of southern part (coastal area) of West Midnapore. It is either woven in residence or in work place. After the partition, Bangladeshi weavers migrated to West Bengal and popularized this handicraft industry even more. On March 28, 2018, Government of West Bengal got a Geographical Indication (GI) tag for *Madur kathi*, under registration no. 567 in respect of handicrafts.

Uses

Mats are used as bedding material or for sitting purpose. It is a poor conductor of heat. Hence, it can be used on hot and cold earthen or cemented floor as well as over bedsheets for comfort. As mat is cheaper in price and durable for at least 3-4 years, poor people can easily afford and buy. It can enhance aesthetic beauty in rituals or functions due to its decoration and colour made by the weavers or naturally. Further, mats can also be used to produce window screen, bags, floor covers, purse, shoes, pen stand, flower vase, fan, folder covers, wall hangings, window curtains, baskets etc. Beside the mat, rhizomes of mat sedge (*Cyperus* sp.) can be used as fodder and for preparation of tonic/medicine, dye and oil.

Package of Practices for Mat Sedge Cultivation

Planting material: Suckers or slips with rhizomes or nuts or bulbs having short length of culms are collected from the place where mat sedge is grown for at least 2-3 years and used as planting material.

Land preparation: Land is prepared through 4-5 ploughings, followed by laddering with shallow depth of water (5-7 cm). One irrigation (5 cm depth) can be applied during final land preparation (if required).

Time and method of planting: The crop is generally planted in May-June under wet soil condition. Rhizomes are covered with straw or moist gunny bags and kept in shade. Water is frequently sprinkled over it for quick sprouting within a week. Although mat sedge being perennial one, can provide economic produce for 10-12 years, it is advised to go for new planting once in 4-5 years in order to maintain quality and quantity. For commercial cultivation, mat sedge is generally planted in line at 30-35 cm row-row distance and 4-5 cm depth. Often, 2-3 rhizomes are planted together to achieve optimum plant population.

Weed management: For efficient weed management, first weeding is done at 20-30 DAS and subsequent ones are done at an interval of 25-30 days in the establishment year. Farmers can pulverize the soil with spade, *khurpi*, *nirani* or wheel hoe for weed suppression as well as better aeration.

Other intercultural operation: old leaves near the ground are required to be removed to eradicate pest infestation.

Water management: Shallow depth of water during emergence of side tillering of crop should be maintained. 5-6 irrigations are required during summer months (Dec-May/June) as irrigation at physiological growth stages played important role in boosting the productivity (Mandal, 1986). Jana and Puste (2014b) observed improvements in growth of mat sedge and soil physico-chemical properties by providing irrigations frequently during winter (2 irrigations) and summer (3 irrigations) seasons along with paddy straw mulching.

Nutrient management: 8-10 days before land preparation, FYM or well decomposed cow dung or other organic manure @ 3-4 t/ha is applied and mixed thoroughly with soil using country plough. 30-40: 50: 50 N: P_2O_5: K_2O kg/ha are applied as basal. Top dressing of nitrogen is done @ 15-20 kg/ha at 30-40 days after planting and @ 20-25 kg/ha after each cutting of the crop. After each application of nitrogen, irrigation can be applied in case of water shortage.

Intercropping: As mat sedge is grown under wetland system; no intercropping is feasible. However, cumin or oilseeds or other species between the rows of sedges can be planted in establishment year.

Plant protection: Mat sedge is generally tolerant to pest and diseases to an extent. However, sometimes stem borer attacks culms, resulting in breakage of stick. Suckers or slips with rhizomes are required to be treated with Chlorpyriphos @ 0.2% and Carbendazim @ 0.1% or Captan @ 0.1% for 8-10 hours or Mancozeb @ 2g + Bavistin @ 1g/litre of water or Kavach @ 2 g + Bavistin @ 1 g or Saaf @ 3 g/litre of water for 5-6 hours. Leaf hopper is another pest which can be controlled by spraying Monocil @ 1.5 ml/ litre of water 2-3 times at an interval of 15-20 days.

Harvesting: Culms are cut before the flower heads dry up. During first year, harvesting or first cutting is made in December-January, if planted in May-June. Subsequent cutting is made in June-July. Culms of first cut are coarse, thick and poor in yield. 2-3 annual harvests of good quality can be achieved from second year onwards. In such case, first cut during October-November as autumn harvest and second cut during February-March as winter harvest and third cut during June-July as summer harvest can be done. Cutting is made at the base of ground and left for 2-3 hours on the field for sun drying. Then, it was taken to drying floor where flower heads and damaged culms are separated and removed. Culms are graded based on the length and quality and dried for 2-3 hours. Thereby, culms are split into 2 or more pieces by knife. Split culms are dried for 1-2 days and bundled. Bundles are 15-20 cm in diameter (30-40 cm circumference) and 15-30 kg in weight. 1 bundle is enough to make 1 mat and width of mat is invariably related to length of culm.

Yield: 2,250 bundles of sticks or culms/ha in October-November (Autumn harvest); 1,500 bundles of sticks or culms/ha in February-March (Winter harvest); 2,250 bundles of sticks or culms/ha in June-July (Summer harvest)

Post-harvest technology (mat making): In order to make mat, culms are split in to 2 or 4 or 8 or 12 or more strands. Thinner the strand, finer will be the mat. Length of culm is generally 1-1.5 m or sometimes even more. Strands of culms are carefully dried until they are rolled length wise, resulting in polished, uniform epidermis on outer side. Splitting of culm is very critical operation, which requires skill and expertise. Generally, 3-4 types of mats are produced viz., plain, striped, super fine etc. Strands are dyed in red, black, green or blue colour with synthetic or natural dyes and used to make different decoration and patterns during mat making. Mats of Chennai (Madras mats) are well decorated, while those of West Bengal (Calcutta mats) are white with striped borders. Mat maker passes strands of culm alternatively over and under the successive threads of warp and presses them home. Sometimes, farmers sell culms in whole sale market or even entire standing sedge in the field to avoid cost of weaving and other inconvenience.

Chemical Composition of Mat Sedge

1. Holo cellulose- 82.92%
2. Alpha cellulose- 41.79%
3. Hemi cellulose- 41.13%
4. Lignin- 13.28%
5. Waxes- 1.73%
6. Moisture- 9.20% (Benazir *et al.*, 2010).

Types of Mats

Mats are generally divided into 3 types based on quality viz., coarse mats (50 counts/culm split in to 2-4 strands; faster to weave), fine mats (80-100 counts/culm split in to 8-20 strands) and super fine mats (120-140 counts/culm split in to 20-40 strands). In Midnapore, mats are known as Ekh-rokha, Do-rokha and Masland. Ekh-rokha is thin/ light mat (single layer). Do-rokha mat (double layer) is thicker and comfortable than Ekh-rokha mat and bound with ribbon at the edges for easy folding. Masland mat is fine quality mat with geometric drawings (designs are self or sometimes magenta colour is painted).

Socio-Economic Impact

Commercial cultivation of mat sedge can give employment opportunity not only for the youth but also for the all the rural people including woman through mat weaving in wetland areas of Chennai, West Bengal, Kerala, Andhra Pradesh, Tamil Nadu etc. Although mat weaving is time consuming, it is an easy job and rural people can spend their livelihood on this small handicraft industry. Mat has multipurpose uses and high demand due to cheap price and comfort. An ordinary mat can cost for 60 to 80 rupees, while well decorated, fine quality mat can be sold in 300 to 2000 rupees or even more. It is worthy to note that people of rural areas where mat sedge is grown, get benefitted socio-economically and their livelihoods are centred around mat sedge production, mat weaving, value addition and marketing. For instances, in Midnapore, West Bengal, income of 77% craft persons is associated with mat weaving. 93% of mat weavers are women in East and West Midnapore. 74% of weavers make hand woven mats and rest develop loom-based products.

Conclusion

Cultivation of mat sedge for weaving of mats holds very good prospects not only uplifting rural socio-economy but also entire nation's economic prosperity. It brings opportunity for all the age, sex, caste, group to sustain livelihood as well as to go for entrepreneurship. However, modern agronomic practices as well as efficient extension service for technology transfusion are very much needed to uplift the productivity of this less known, traditional, wet land crop which can boon the mat industry and popularize this age-old rural handicraft even more.

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Diversifying Rice Based Copping Systems - A Need of the Hour

Article ID: 35137

Sheri Vaishnav[1]
[1]Ph.D. Scholar, Department of Agronomy, PJTSAU, Hyderabad-30.

From the known time, bonding between the Indian farmer and rice crop is inseparable. various reasons like staple food and suitable climate across the country has led to socioeconomical integration of this crop in the farming community. Many crop improvement programs from the scientific communities along with continuous increase in irrigation infrastructure associated with rice across the country is the reason for today's huge production levels (115 Mt).

Though rice is the staple food of majority of people in the country, with rapid urbanization, globalization and increased economic stability of the people a change in food habits and concern over diet are also surfacing as a result of which preference to rice is decreasing day by day drawing urgent attention toward diversifying rice based cropping systems to alternate crops which are in demand. Further, the importance of prevailing rice based cropping system is now-a-days losing ground due to decrease in factor productivity and poor resource use efficiency which are responsible for low profits to the farmer. The above-mentioned challenges are throwing new targets before scientific communities in achieving sustainability of rice based cropping systems.

Rice-wheat, rice-rice and rice-maize are the most popular and wide spread cropping systems in the country covering significant portion of the gross cultivated area. Since all these crops are cereals which are nutrient exhaustive crops and demand large quantities of externally supplied nutrients. Dumping such huge quantities of nutrients not only increases cost of cultivation but also pose serious environmental pollution.

On the other side production levels of rice and wheat in the country is over and above the requirement. As government agencies are major procuring agencies of this crops, over production of them is creating an imbalance between demand and supply resulting in price drop. with various political and social reasons government is purchasing most of the cereals from the farming communities in spite of huge losses. While on other side domestic consumption of edible has increased in many folds in the last two decades and the same trend is expected to continue in the coming days. Whereas production levels of oilseeds in India are not increasing in proportionate to the demand. To fulfil domestic needs, India is importing huge quantities of oilseeds from foreign countries by spending most valuable foreign reserves.

It is high time to focus on crop diversification, particularly cereal based cropping systems. As major crops like rice and wheat are staple food crops of the country it is not advisable to completely shift from those crops but substituting rice/wheat/maize with legumes and oilseeds to a portion can make cropping systems sustainable which are environmentally safe and economically profitable.

This diversification has the potential to address various issues like water productivity, nutrient use efficiency and land degradation problems. After a lot of work in these aspects, crops suitable to different locations of the country are identified and are shown in Table no. 1.

Table 1. Recommended alternate cropping systems for different regions:

Region	Existing system	Recommended system
Karnal, Haryana	Rice-wheat	Rice - vegetable pea - wheat-greengram
Jabalpur (MP)	Rice-chickpea	Hybrid rice-gobhi sarson-okra
South Gujarat	Rice-wheat	Rice-sorghum-sorghum ratoon Rice-sweet corn-blackgram Rice-greengram-groundnut
Krishna –Godavari delta	Rice-rice	Rice-mustard, rice-greengram/blackgram

Karnataka	Rice-maize	Rice-soybean
Odisha	Rice-fallow	Rice-utera blackgram
Assam	Rice-rice	Winter rice–cabbage- greengram Rice–chilli–blackgram

(Source: Panda *et al.*)

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Need of Biotechnology in Crop Improvement

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Om Prakash Yadav[1], Babulal Choudhary[2], Harpreet Singh[3]
[1]Ph.D. Research Scholar, Department of Genetics and Plant Breeding, CCSHAU, Hisar, Haryana, 125004.
[2]Ph.D. Research Scholar, Department of Soil Science, CCS HAU, Hisar, Haryana, 125004.
[3]Ph.D. Research Scholar, Genetics and Plant Breeding, PAU, Ludhiana, Punjab, 141027.

Introduction

The United Nations has predicted that the world's population will increase by 25% to 7.5 billion by 2020. On average, an additional 73 million people a year, 97% of whom will live in developing countries. Currently, about 1.2 billion people live in 'extreme poverty', where 800 million people live under insecure food security, and 160 million preschoolers suffer from malnutrition. A large number of people also suffer from deficiency of nutrients such as iron, zinc and vitamin A. Food insecurity and malnutrition lead to serious public health problems, and human energy loss. The amount of land available for crop production is slowly declining due to urban sprawl and land degradation, and the situation is expected to be much higher for the developing world than for the developed world. In 1990, only Egypt, Kenya, Bangladesh, Vietnam and China yielded less than 0.25 ha per person. However, by 2025, countries such as Peru, Tanzania, Pakistan, Indonesia and the Philippines are likely to join the group. This decline in the amount of land available for crop production and population growth will have a significant impact on food security over the next 2_/3 years. The first significant increase in grain production was due to increased cultivation, irrigation, better farming practices, and improved crops. The fruits of several crops have already reached the plateau in developed countries, therefore, greater profits for future production will have to be obtained in developing countries through better management of natural resources and crop improvement. Product gains are important for long-term economic growth, but in the short term, this is critical to maintaining a sufficient diet for the world's growing population.

Biotechnology will play an important role in food production in the near future. In this review, we try to look at the critical but visible aspects of the prospects and challenges of the various forms of biotechnologies and their use in crop production and to improve the quality of healthy food. Within this, we also look at the critical issues of insecurity and the impact of genetically modified plants on the environment. Genetic engineering gives horticulturalists access to countless genetic variants, which can be incorporated in a single case into the more productive and local crops. This approach provides rapid entry of genes and traits into agronomic domains.

The future effects of biotechnology on crop production will be in the areas of:
1. Development of new hybrid plants according to male reproduction,
2. Use transgenic apomixes to adjust the hybrid potential of indoor plants,
3. Increase resistance to pests, diseases, and conditions of abiotic stress,
4. Improving the effectiveness of bio-control agents,
5. Improve the nutritional value (vitamin A and iron) of plants and post-harvest quality,
6. Increase efficiency of phosphorus soil acquisition and nitrogen fixation,
7. Improve adaptability to soil salts and aluminum toxins,
8. Understanding the nature of genes and mechanisms,
9. Increase photosynthetic activity, sugar and starch production,
10. Manufacture of medicines and vaccines.

New types of pest and disease-resistant crops combined with bio-control agents should lead to a reduction in dependence on pesticides, and thus reduce the cost of protecting farmers' crops, while benefiting the environment and public health. Similarly, genetically engineered weed control to achieve effective and cost-effective weed control can increase farm income, while reducing the need for weed control and herbicide use. Agricultural work can be used for other profitable activities. In addition, there is an urgent need for less efficient agricultural practices in countries most affected by HIV. By increasing crop production, agricultural biotechnology can replace the need to cultivate new land and thus preserve biodiversity in areas under crop production.

Biotech plants can provide improved quality features such as elevated levels of beta-carotene rice to help reduce vitamin A deficiency and improved fat production in canola, soybeans, and corn. Plants that have the potential to grow in saline or better drought tolerant soils are also active and the first such products have recently entered the market. Such inventions can be even more important in adaptation or in some cases help to reduce the effects of climate change. Agricultural biotechnology tools are very important for researchers in helping to understand the basic biology of living organisms. For example, scientists have discovered the complete genetic makeup of several Listeria and Campylobacter viruses, bacteria that often cause large outbreaks of human-borne diseases. This genetic information provides a wealth of opportunities to help researchers improve the safety of our food supply.

The power of this technology has been extensively tested on cool and underground agricultural crops. However, there is an urgent need to focus on growing crops suitable for smallholder farmers and poor consumers in developing countries in tropical and subtropical regions. The promise of biotechnology can be fulfilled by using the data and products generated by genomics and transgenic research to increase plant productivity by increasing resistance to biotic and abiotic stress factors and the quality of healthy food.

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India's Water is Being Exported as Agriculture Export- Virtual Water Trade is a Solution!

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C. M. Rajesh[1], Soumya Hiregoudar[2]

[1]Ph.D Scholar, Department of Agricultural Extension, University of Agricultural Sciences, GKVK, Bangalore-560 065.

[2]Ph.D Scholar, Department of Food Science and Nutrition, University of Agricultural Sciences, GKVK, Bangalore-560 065.

Introduction

Central Water Commission of India has reported that about 78% of water consumption in India is done by the agricultural sector. For 2020-21, India registered a growth of 17.34 percent in agricultural exports. But we failed to look beyond the growth in agricultural exports. Agricultural exports deplete an equivalent amount of irrigation water permanently from the country's resource base. So, it is important for regulating water in Agricultural exports. So, It is critical for us to adopt the circular water management model of treating and rejuvenating wastewater at the source to reduce water demand.

In 2015 the global community committed to the UN Sustainable Development Goal 6, which promises that by 2030 everyone will have a safe supply of water available whenever they need it. However, the progress on it has not been up to the mark. Recently, the WaterAid released its report, 'Beneath the Surface: The State of the World's Water 2019' on March 22, the World Water Day. This report reveals that some 4 billion people in the world live in physically water-scarce areas and 844 million don't have access to clean water close to home. Key findings for India in the report:

India's rate of groundwater depletion increased by 23% between 2000 and 2010.

1. India is the third largest exporter of groundwater – 12% of the global total.
2. India also uses the largest amount of groundwater – 24% of the global total.
3. As many as one billion live in areas of physical water scarcity, of which 600 million are in areas of high to extreme water stress.
4. 88% of households have clean water close to home.
5. 75% of households do not have drinking water on the premises.
6. 70% of drinking water is contaminated.

Agricultural Exports and Water Stress

India's agricultural exports registered a growth of 17.34 percent, garnering $41.25 billion in foreign exchange for 2020-21, despite the novel coronavirus disease (COVID-19) pandemic. For instance, the improved agricultural exports for 2020-21 are equivalent to the annual drinking water needs of 1,500 villages with a population of 1,000. So, the Agricultural exports reduce the imbalance in trade and earn hard currency while causing social, environmental fallouts, primarily for rural people.

Ashok Gulati, an agriculture economist, views the continuing agriculture export of crops like rice and sugarcane with deep concern. For him, the export of 17.7 million tonnes of rice and 7.5 million tonnes of sugar is the same as the export of 50.4 billion cubic meters of water by the current generation from the legitimate resource share of the future.

What is Virtual Water Trade (VWT)?

The virtual water trade is the idea that when goods and services are exchanged, so is virtual water. When a country imports one tonne of wheat instead of producing it domestically, it is saving about 1,300 cubic meters of real indigenous water.

Virtual Water Trade at the Global Level

Virtual Water Trade (VWT) is slowly altering the global hydrological cycle in many ways. Several countries have begun to act early, adopting the VWT route to address worldwide water distress. For instance, water-guzzling activities are getting outsourced for production to other countries. Thus, crops, meat, leather, chemicals, and industrial goods are imported to ensure a positive water balance. For example, Mexico imports maize and in doing so, it saves 12 billion cubic meters per year of its national water resources. Globally, the largest water exporters are the US, China, Australia, India, Pakistan, Brazil, Canada, Vietnam, Indonesia, and Thailand.

The Situation in India

1. Unfortunately, India has fallen for this bait and is getting increasingly entrapped into agricultural exports. Agri-export houses are earnestly exporting virtual water, especially groundwater, all for a dime.
2. India has witnessed a continued decline in its per capita water availability — by 60 percent over the last 50 years because of increasing water use by the irrigation sector and India's agricultural exports.

Why Agricultural Export is Used as a Proxy for the Transfer of Embedded Water?

1. Remains unnoticed from the exporting country: The visible impact on a national scale remains unnoticed, as a mere one to four percent of the total water gets depleted per annum through the agri-exports route. However, this impact is significant enough to create an enormous imbalance at the local level in different regions
2. Countries generally import water-intensive crops and products and balance this import by exporting less water-intensive commodities.
3. Generates revenue for exporting nation: Exporting countries view the exports as a revenue-generating one and the way to boost farmer's income in their country. But in the long run, the result is the opposite.

Why does India Need to Pay Attention to Virtual Water Trade?

1. Virtual water export is likely only to grow further in the future. Its impact on coming generations would be more catastrophic if corrective actions are not taken at the earliest.
2. VWT, covering both export and import, is here to stay and cannot be avoided, just as oil import is accepted as critical for economic growth.

Suggestions

1. Virtual Water Trade (VWT) risks need to be integrated into the policy framework to help anticipate the concerns and design management practices, to help soften water footprint export volumes. The policy should include:
    a. Fix the upper limits of national VWT.
    b. List the products and regions that need to be excluded from it.
    c. Specifications on water types to be used.
    d. Wastewater treatment and reuse.

2. A national guideline needs to be designed to help map the volumes of water already lost from the hydrological cycle due to export and ways to offset the loss through improved management strategies:
    a. Precision technology to be adopted to trail water use by export farms and industries
    b. Water footprint estimation guidelines to be adopted by the different production systems
    c. Design 'water renewal credit' similar to 'Carbon credit'
    d. 'Water renewal credit' is the first step to revive wastewater into productive use within the hydrologic cycle for irrigation / non-drinking use.

e. 'Water renewal credit' overtime needs to be extended to bottling water plants, commercial water users, bulk water users involved with entertainment and sports.
f. In the future, 'Water renewal credit' to be acquired in advance to be eligible for export.
g. All export houses shall treat wastewater equivalent to the virtual water exported.

Conclusion

With future challenges, it is critical to adopt the circular water management model of treating and rejuvenating wastewater at source combined with efficient water management strategies to reduce the water demand by at least 50 percent to restore the balance by adopting the bottom-up approach.

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Status of Organic Farming: Relevance & Future Prospectus in India

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Kadapa Sreenivasa Reddy[1], Gunturi Alekhya[1], Billa Suresh Kumar[2]
[1]Ph.D (Ag.) Scholar, Division of Agronomy, ICAR- Indian Agricultural Research Institute, Newdelhi-110012.
[2]Ph.D (Ag.) Scholar, Department of Agronomy, Ag.College, Bapatla, ANGRAU.

The term 'organic' was first coined by Northbourne, in 1940, in his book entitled 'Look to the Land'. Northbourne also defined organic farming as 'an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity organic produce is not grown with synthetic pesticides, antibiotics, growth hormones, application of genetic modification techniques (such as genetically modified crops), sewage sludge, or chemical fertilizers.

Organic food and farming have continued to grow across the world. Since 1985, the total area of farmland under organic production has been increased steadily over the last three decades (Willer and Lernoud, 2019). By 2017, there was a total of 69.8 million hectares of organically managed land recorded globally which represents a 20% growth or 11.7 million hectares of land in comparison to the year 2016. This is the largest growth ever recorded in organic farming (Willer and Lernoud, 2019). Australia has the largest organic lands with an area of 35.65 million hectares and India acquired the eighth position with a total organic agriculture area of 1.78 million hectares (Willer and Lernoud, 2019). In 2017, it was also reported that day to day the number of organic produces increases considerably all over the world. Asia contributes to the largest percentage (40%) of organic production in the world and India contributes to be largest number of organic producer (8,35,000). The growth of organic farming in India was quite dawdling with only 41,000 hectares of organic land comprising merely 0.03% of the total cultivated area. In India during 2002, the production of organic farming was about 14,000 tonnes of which 85% of it was exported (Chopra *et al.*, 2013). The most important barrier considered in the progress of organic agriculture in India was the lacunae in the government policies of making a firm decision to promote organic agriculture. Moreover, there were several major drawbacks in the growth of organic farming in India which include lack of awareness, lack of good marketing policies, shortage of biomass, inadequate farming infrastructure, high input cost of farming, inappropriate marketing of organic input, inefficient agricultural policies, lack of financial support, incapability of meeting export demand, lack of quality manure, and low yield (Bhardwaj and Dhiman, 2019).

Government of India Role in Promoting Organic Agriculture

Recently, the Government of India has implemented a number of programs and schemes for boosting organic farming in the country. Among these the most important include (1) The Paramparagat Krishi Vikas Yojana, (2) Organic Value Chain Development in North Eastern Region Scheme, (3) Rashtriya Krishi Vikas Yojana, (4) The mission for Integrated Development of Horticulture (a. National Horticulture Mission, b. Horticulture Mission for North East and Himalayan states, c. National Bamboo Mission, d. National Horticulture Board, e. Coconut Development Board, d. Central Institute for Horticulture, Nagaland), (5) National Programme for Organic Production, (6) National Project on Organic Farming, and (7) National Mission for Sustainable Agriculture (Yadav, 2017). Paramparagat Krishi Vikas Yojana since 2015–16 and Rashtriya Krishi Vikas Yojana are the schemes taken by the Government of India under the ZBNF policy. Accordingly in the union budget 2020–21, Rs 687.5 crore has been allocated for the organic and natural farming sector which was Rs 461.36 crore in the previous year. Indian Competence Centre for Organic Agriculture cited that the global market for organically grown foods is USD 26 billion which will be increased to the amount of USD 102 billion by 2020. India ranked 8th with respect to the land of organic agriculture and 88th in the ratio of organic crops to agricultural land as per Agricultural and Processed Food Products Export Development Authority and report of Research Institute of Organic Agriculture But a significant growth in the organic sector in India has been observed in the last decades. There have been about a threefold increase from 528 171 ha in 2007–08 to 1.2 million ha of cultivable land in 2014–15. As per the study conducted by Associated Chambers of Commerce & Industry in India, the organic food turnover is increasing at about 25% annually and thereby will be expected to reach USD 1.36 billion in 2020 from USD 0.36 billion in 2014.

Organic Agriculture: Its Relevance to Indian Farming

Only 30% of India's total cultivable area is covered with fertilizers where irrigation facilities are available and in the remaining 70% of arable land, which is mainly rain-fed, negligible number of fertilizers is being used. Farmers in these areas often use organic manure as a source of nutrients that are readily available either in their own farm or in their locality.

The northeastern region of India provides considerable opportunity for organic farming due to least utilization of chemical inputs. It is estimated that 18 million hectare of such land is available in the NE, which can be exploited for organic production. With the sizable acreage under naturally organic/default organic cultivation, India has tremendous potential to grow crops organically and emerge as a major supplier of organic products in the world's organic market.

The report of the Task Force on Organic Farming appointed by the Government of India also observed that in vast areas of the country, where limited amount of chemicals is used and have low productivity, could be exploited as potential areas for organic agriculture. Arresting the decline of soil organic matter is the most potent weapon in fighting against unabated soil degradation and imperilled sustainability of agriculture in tropical regions of India, particularly those under the influence of arid, semiarid and subhumid climate. Application of organic manure is the only option to improve the soil organic carbon for sustenance of soil quality and future agricultural productivity.

Future Prospects of Organic Farming in India

India is an agriculture-based country with 67% of its population and 55% of manpower depending on farming and related activities. Agriculture fulfils the basic needs of India's fastest-growing population accounted for 30% of total income. Organic farming has been found to be an indigenous practice of India that practiced in countless rural and farming communities over the millennium.

The arrival of modern techniques and increased burden of population led to a propensity towards conventional farming that involves the use of synthetic fertilizer, chemical pesticides, application of genetic modification techniques, etc. Even in developing countries like India, the demand for organically grown produce is more as people are more aware now about the safety and quality of food, and the organic process has a massive influence on soil health, which devoid of chemical pesticides.

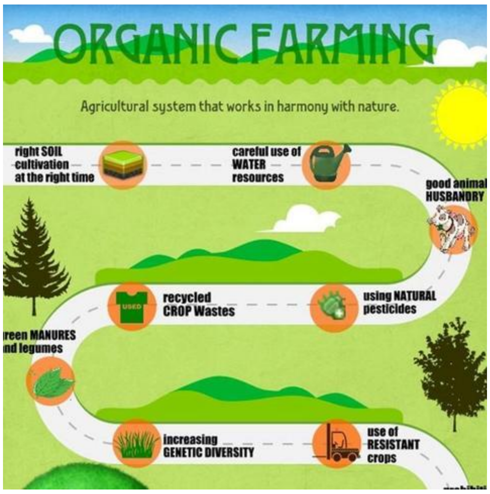
Organic cultivation has an immense prospect of income. Indian traditional farmers possess a deep insight based on their knowledge, extensive observation, perseverance and practices for maintaining soil fertility, and pest management which are found effective in strengthening organic production and subsequent economic growth in India.

The progress in organic agriculture is quite commendable. Currently, India has become the largest organic producer in the globe (Willer and Lernoud, 2017, 2019) and ranked eighth having 1.78 million ha of organic agriculture land in the world in 2017.

Conclusion

The interest in organic agriculture in developing countries is growing because it requires less financial input and places more reliance on the natural and human resources available. Organic agriculture offers comparative advantage in areas with less rainfall and relatively low natural and soil fertility levels.

Organic agriculture does not need costly investments in irrigation, energy and external inputs, but rather organic agricultural policies have the potential to improve local food security, especially in marginal areas. Organic farming yields more nutritious and safe food. The popularity of organic food is growing dramatically as consumer seeks the organic foods that are thought to be healthier and safer. Thus, organic food perhaps ensures food safety from farm to plate. The organic farming process is more eco-friendly than conventional farming.



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Role of Acetic Acid Bacteria in Sustainable Agriculture

Article ID: 35141

Anandakumar Selvaraj[1], Umapathi Muniyappan[2]
[1]Department of Agricultural Microbiology, Tamil Nadu Agricultural University, Coimbatore – 641 003.
[2]Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore – 641 003.

Introduction

An emerging trend in agriculture, the use of plant growth promoting bacteria (PGPB) to improve plants growth and health is an alternative way to avoid the negative effects generated owing to overuse of inorganic fertilizers and chemicals to increase agricultural production to meet the global demand. Globally well renowned that application of PGPB improves crop performance through various direct and indirect mechanisms, such as biological nitrogen fixation (BNF), phytohormones production, mineral nutrients solubilization, siderophore production, *etc*. Besides, it also improves plant's tolerance to diverse biotic and abiotic environmental stimuli. Some of the important and well known PGPB such as *Rhizobium*, *Azospirillum*, *Azotobacter*, *Sinorhizobium*, *Gluconacetobacter*, *Bacillus*, *Pseudomonas*, *Burkholderia*, *Frankia*, *Azoarcus*, *Herbaspirillum*, and *Serratia* are utilized in the agricultural system for sustainable crop production. Moreover, acetic acid bacteria (AAB) is one among them reported to enhance plant growth and health through imparting different plant growth promoting mechanisms, including nitrogen fixation, phytohormones production, mineral nutrients solubilization, exhibiting antagonistic effect against pathogens, *etc*.

Occurrence of Plant Growth Promoting (PGP) Acetic Acid Bacteria (AAB)

Acetic acid bacteria (AAB) are Gram negative, acidophilic α-proteobacteria belonging to the family Acetobacteraceae, they are able to oxidize sugars and ethanol as substrate to acetic acid in neutral and acidic media under aerobic conditions. They have the ability to grow in very acidic environments with pH close to 3.0–3.5, but the optimum range is 5.0–6.5. Acetobacteraceae covers ten important genera includes *Acetobacter*, *Gluconacetobacter*, *Gluconobacter*, *Acidomonas*, *Asaia*, *Kozakia*, *Saccharibacter*, *Swaminathania*, *Neoasaia,* and *Granulibacter*. Among them, *Gluconacetobacter*, *Acetobacter,* and *Swaminathania* are prominently reported in plant systems, which promote plant growth and health. This AAB are associated with diverse plant species, colonizing the inner tissues and roots to promote plant growth through direct or indirect mechanisms besides N_2 fixation, including synthesis of phytohormones, solubilization of nutrients, and antagonistic effects against phytopathogens (Table 1). Moreover, AAB is also found in the rhizosphere of many plants and establishes a more specific association with plants tissues as an endophyte.

Table 1. Occurrence of plants associated acetic acid bacteria (AAB) and their significant plant growth promoting (PGP) traits:

AAB	Associated with	PGP traits
G. diazotrophicus	Sugarcane, sweet potato, Cameroon grass, coffee, pineapple, finger millet, tea, mango, rice, and banana	N2-fixation Auxin production Gibberellin production Phosphate solubilization Zinc solubilization Siderophores Production
G. johannae and *G. azotocaptans*	Coffee and maize	N2- fixation
G. kombuchae	Kombucha tea	N2- fixation
Acetobacter peroxydans	Rice	N2- fixation
A. nitrogenifigens	Kombucha tea	N2- fixation
Swaminathania Salitolerans	Wild rice	N2- fixation and phosphate solubilization

Nitrogen Fixation

Nitrogen fixation is a biological process that guarantees that the atmospheric N_2 is incorporated into organic matter by several bacterial groups. Biological nitrogen fixation (BNF) is an enzymatic reduction of the atmospheric dinitrogen (N_2) to ammonia, catalyzed by the nitrogenase complex. This process is exclusive to Bacteria and Archaea, and the microorganisms that fix nitrogen are named diazotrophs. AAB belongs to the genera *Gluconacetobacter*, *Acetobacter* and *Swaminathania* are able to fix atmospheric N_2 (Table 1).

Genera, *Gluconacetobacter diazotrophicus* formerly called *Acetobacter diazotrophicus*, is the first identified N_2 fixing AAB isolated from sugarcane plant tissues by Johanna Döbereiner and her co-worker. *G. diazotrophicus* is found to have high sucrose tolerance (10 %), able to grow and fix nitrogen at low pH (5.0 or less), and chocolate colonies on potato agar medium with 10% sucrose. Besides, it is also associated with other plant species include sweet potato, *Pennisetum purpureum*, coffee, pineapples, finger millet, tea, rice, mango fruits, *etc*.

Further, it is also found in the rhizosphere of different plants species include bananas. Similarly, *Swaminathania salitolerans*, a salt-tolerant, N_2 fixing, and phosphate solubilizing acetic acid bacterium was isolated from wild rice plants. Moreover, *Acetobacter peroxydans* were also reported to N_2-fixer associated with rice varieties to improve plant growth.

Phytohormones Production

It is well known that phytohormones are important as signals and regulators of growth and development in plants. The production of hormonal substances such as auxins and gibberellins by different PGPB has been proposed as one of the plant growths promoting mechanisms besides N_2-fixation. Notably, indole-3-acetic acid (IAA) and gibberellins (GA) are important plant growth regulators reported to produce by *G. diazotrophicus* and other AAB.

Mineral Nutrients Solubilization

Plant growth and development depend on the availability of inorganic mineral nutrients in the soil. Phosphate is the second most important nutrient besides nitrogen, fixed in the soil by biological nitrogen process, make available to plants by microbial solubilization. Mineral phosphate solubilization is generally considered to be a plant growth promoting characteristic for PGPB. This activity has been observed in different strains of *G. diazotrophicus* and *S. salitolerans*.

PGPB including *G. diazotrophicus* able to solubilize insoluble P and Zn compounds by producing inorganic acids. Similarly, *Swaminathania salitolerans* were also reported to solubilize phosphate. Zinc is an essential micronutrient in crop production; its deficiency is widespread in arable soils and is also frequent in the host crops of *G. diazotrophicus*, such as sugarcane, rice, and coffee. Therefore, solubilization of insoluble Zn compounds by *G. diazotrophicus* may enhance the Zn nutrition of host crops.

Another essential micronutrient is iron. To maintain growth, bacteria have developed different strategies to obtain iron from the iron-limited environment, but siderophore-mediated iron uptake is probably the most common form of iron acquisition. It has been reported that *G. diazotrophicus* produces hydroxamate-type siderophores.

Antagonistic Activity of AAB Against Phytopathogens

PGPB can inhibit the growth of several phytopathogens in different ways; competing for space and nutrients, producing bacteriocins, lytic enzymes, antibiotics, and siderophores. Similarly, *G. diazotrophicus* was reported to produce a bacteriocin that inhibits the growth of *Xanthomonas albilineas*, the causal agent of leaf scald disease in sugarcane, as well as having resistance to different antibiotics and heavy metals. The endophytic colonization of rice roots by *G. diazotrophicus* proved to activate pathogen-related genes of the jasmonic acid pathway and it upregulated the transcript levels of ROS-detoxifying genes such as superoxide dismutase and glutathione reductase. Moreover, the ability of *G. diazotrophicus* to antagonize diverse plant pathogens, such as fungi and bacteria, contributes to increasing its ability to survive under environmental stress and leads to an improvement in plant fitness, which may have significant consequences for agricultural productivity. Additionally, *G. diazotrophicus* also produce a wide variety of proteins such as lytic enzymes and phospholipases, and antibiotics that could be toxic to other organisms.

Table 2. Effect of AAB on plant growth and development:

Acetic acid bacteria and Other PGPB	Crop	Beneficial effects on plants
G. diazotrophicus + *Burkholderia vietnamiensis*	Sugarcane	Improved sugarcane yield
G. diazotrophicus	Tomato	Increased numbers and weight of fruit
G. diazotrophicus + *Trichoderma sp.*	Sugarcane	Improved soil quality and sugarcane ratoon yield
G. diazotrophicus	Sorghum	Augmented shoot fructose and glucose level
G. diazotrophicus	common bean	Induced secondary metabolites accumulation
G. diazotrophicus + *Glomus intraradices*	Sorghum	Significantly increased root endoglucanase, endopolymethylgalacturonase and endoxyloglucanase activities
G. azotocaptans + *Pseudomonas putida* + *Azospirillum lipoferum*	Corn	Significant improved plant growth

Conclusion

Bacterial inoculation of plants to enhance the yield of crops is a century-old proven technology for rhizobia and a newer venue for PGPB. The use of AAB as inoculants in agriculture is something new to promote plant growth through more than one mechanism, such as the biological N_2-fixing process, production of phytohormones, and solubilization of mineral nutrients. Therefore, AABs as an alternative method to fertilizers and chemical substances may play a significant role in improving plant growth, increasing crop productivity, saving the environment, and improving agricultural sustainability.

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Nutrigenomics – An Emerging Field of Genomics in Nutrition Research

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Rubina Khan[1], Anju Nehra[1]
[1]Department of Plant Breeding and Genetics, S.K.N. Agriculture University Jobner, Jaipur 303328 (Rajasthan).

Abstract
Nutrigenomics is defined as the application of genomics in the field of nutrition research to study the way in which food or diet influences gene expression and gene regulation. It unrevealed the association between specific nutrients and genetic factors. It is a multidisciplinary approach which brings together the science of bioinformatics, nutrition, molecular biology, genomics, epidemiology and molecular medicine. Nutrigenomics focuses on the effect of ingested nutrients on genome, proteome and metabolome.

It is combination of molecular nutrition with genomics providing a snapshot on the effects of gene/protein networks that results in production of the observed response. In this modern era, people are becoming more prone to diet related disorders with their changing life styles and food habits.

Hence, there is an urgent need to boost more research in this emerging science which enables us to understand the relationship between diet and health and ensures that everyone benefits from this genomic revolution. The ultimate aim of nutrigenomics is prevention than cure which holds good to the dictum of Hippocrates - Father of Medicine, who said "Leave your drug in the chemist's pot if you can heal the patient with food".

Introduction
Nutrigenomics helps in establishing the relationship between the effects of ingested nutrients on gene expression and gene regulation and facilitates prevention of diet-related common diseases, such as cancer, type-2 diabetes, obesity and cardiovascular disease. It is the junction between health, diet and genomics.

This field came into existence with the growing awareness about the potential effects of the modifications of food or diet supporting health and reducing the risk of diet related diseases. So, there is a need to shift from Epidemiology and Physiology to Molecular Biology and Genetics.

Nutrigenomics enables us to determine the individual's nutritional requirements, that is, personalised nutrition which in turn will help in designing and prescribing a diet for a particular individual based on the genetic makeup and their genetic variations, e.g., the development of customized nutraceuticals and foods for specified health use, such as foods for hypertension, high cholesterol, diabetes, etc.

Thus, the main aim of nutrigenomics research is to study genome-wide influences of nutrition addressing the role of metabolic stress in the genesis of particular metabolic syndrome. This goal is based on the idea that nutrition can be complementary to pharmacological therapy which targets the pathophysiological aspects of disease and should focus primarily on restoring health and fitness and preventing diet-related disease.

Nutrigenomics Research Tools
In the post-genomic era, a wide variety of new tools are available that opens new ways for a nutritionist to develop such dietary strategies that helps in supplying the optimum nutrition to a particular individual by screening the genetic background and monitoring the transcriptome, proteome and metabolome. The use of microarray or DNA chip technology has now revealed new information regarding physiological effects of different dietary proteins.

The interactions between diet and genes which are measured as changes in the genetic expression can be evaluated by DNA microarray technology and quantitative real time Polymerase Chain Reaction (PCR). It not only enables the simultaneous screening of large number of genes but also explains the complex regulatory interactions between diet nutrients and genes (Zduńczyk and Pareek, 2009).

Biomarkers

Nutrigenomics is a revolutionary way in which food is not viewed just for sustenance but as a pharmaceutical capable of reversing disease and stalling the rigors of ageing (Bhatt and Sharma, 2011). It involves finding markers at an early phase of diet related diseases in which intervention with nutrition can return the patient to normal health (Ramesha *et al*., 2010).

Biomarkers can manipulate gene expression by utilization of nutrients or their combinations so as to improve productive as well as overall performance of any individual.

Functional Foods

Functional foods have a specific health-promoting or enhancing effect over and above their nutritional content, such as cholesterol-lowering foods and probiotic yoghurts present in the markets. These are proving an important application which can be particularly useful and offer added value over and above generalised dietary advice.

Nutrigenomics & Diseases

Nutrigenomics is widely used for studying heart as well as diet related disorders (Sivasankaran, 2010; Rastogi *et al*., 2004). People consuming excess fat and calorie-rich foods have an increased pervasiveness of diabetes and obesity.

In India, although the rate of fatal diseases is lower than in western countries but this rate is mounting in urban dwellers with advancement in their lifestyles (Sharma and Majumdar, 2009). To prevent the development of chronic diet related disease, it is essential to investigate how nutrition can optimize and maintain cellular, tissue, organ and whole-body homeostasis which in turn requires the knowledge of the manner in which ingested nutrients act at the molecular and metabolic levels.

Nutrigenomics & Public Awareness

Nutrigenomics is a topic of controversy also. The public concern over nutrigenomics is very much relevant to science and food industry. The past and present food frights, such as use of genetically modified foods, illustrates the importance of addressing public concerns sooner rather than later, and of taking the social issues around science as seriously as technical ones.

An appropriate guideline is required to ensure responsible use of research and to assure the public that these products can be trusted. The manufacturers of these products must need a proper regulatory framework and engaging the public to demonstrate their will to improve the safety, reliability and health benefits of their products (Sherwood, 2006).

It is well understood that the genes we inherit cannot be altered, but certainly one can change its response to the environment (dietary) and obtain the desired results. Healthy food choices are fundamental in the prevention of both under and over nutrition. Hence, a multidisciplinary group comprising nutritionists, agriculturists, technologists, home scientists, dieticians etc. should be constituted to develop Food Based Dietary Guidelines (FBDG) whose ultimate objective is to grow what is needed and preserve what is required.

Conclusion

Nutrigenomics is a revolutionary science which helps in developing public health strategies to reduce the incidence of diet related diseases and helps to understand the adverse or beneficial effects of some food or nutrients on human health. But this approach would require a collaborative effort from people in genetics and the industries of public health, food science and culinary. It's very easy to make good-tasting food. The main challenge is how to take the fat out and make heathy and good-tasting food. With an increasing incidence of obesity and chronic diseases such as type-2 diabetes, nutrigenomics might prove to be the panacea in the future. It is certainly an interesting evolving science with many areas to be investigated further and from different perspectives as it involves ethics, medicine, genetics and nutrition.

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Expression of Human Fat Mass and Obesity Gene in Transgenic Rice

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Sandra Ann Litto[1]
[1]III BSMS, Indian Institute for Science Education and Research (IISER), Thiruvananthapuram, Kerala.

Introduction

Genetic engineering for developing genetically modified (GM) crops has been attempted since 1980's to develop recombinants of desired traits. Four decades apart, around 2000 million hectares of GM crops are being cultivated worldwide. GM crops are developed by inserting DNA fragments for desired traits into host genome through an appropriate vector with the objective of producing a recombinant genome with improved traits, some examples being pest resistance, herbicide resistance, enhanced yield, storage and quality. GM crops have become a possible alternative for improved grain yield, better quality and reduced cost of production.

Prospects of Transgenic Rice

Rice (*Oryza sativa* L.) is one of the most important food crops, being the staple food for over half the world's population. Several researches on transgenic rice with designed traits such as increased yield, high protein content, pharmaceutical proteins, high vitamin content, pest resistance, herbicide resistance and salt tolerance have been extensively carried out (Jia *et al*. 2004).

Golden rice is a popular example of transgenic rice which could biosynthesize beta-carotene, a precursor of vitamin A. Golden rice was engineered with the objective of alleviating dietary vitamin A deficiency among populations of developing countries. It is a transgenic derivative with a genetic construct containing a phytoene synthase (*psy*) gene within rice nuclear genome and placed under the control of an endosperm-specific promoter, so that they are only expressed in the endosperm. Golden rice 1, transformed with a construct containing *psy* gene from daffodils produced 0.8 μg β-carotene per gram of dry rice and golden rice 2, developed with *psy* gene from maize produced about 35 μg β-carotene per gram of dry rice (Paine *et al*., 2005).

Transgenic rice is a potential producer of pharmaceutical proteins also. However, recombinant proteins competing with endogenous storage proteins lead to low yields of recombinant proteins. Hence, endogenous storage proteins in rice were suppressed by RNA interference (RNAi) or post transcriptional gene silencing (PTGS) to develop transgenic rice seeds with more efficient protein expression system. Human growth hormone (hGH) was expressed in transgenic rice seeds using an endosperm specific promoter from a 10 kDa rice prolamin gene. RNAi cassette was inserted into the hGH expression construct which effectively suppressed the expression levels of 13 kDa prolamin and glutelin. As a result, hGH polypeptides accumulated to about 470 µg/g dry weight in transgenic rice seeds (Kevin *et al*., 2005).

Similarly, seed specific and readily extractable human lysozyme expressed in transgenic rice under the control of the Tapur cassette. Lysozyme of Tapur cassette localized in protein bodies I and II in rice endosperm cells indicated that this signal peptide can be used for targeting human lysozyme to rice protein bodies. Kevin *et al*. (2005) reported that by using the Tapur cassette with well-established transgenic Gt1 system, the expression level of human lysozyme increased from 5.24 mg/g of flour to 9.24 mg/g of flour in transgenic rice.

Transgenic Rice with Human FTO Gene

FTO gene is the fat mass and obesity associated gene expressed in humans, which is responsible regulating growth and may lead to obesity risks in man and animals. It is an alpha-ketoglutarate dependant dioxygenase enzyme. The protein encoded by the FTO gene plays a regulatory role in the growth of living things by removing chemical markers from RNAs that read DNA information. It modifies RNA strands encoding the specific growth protein, thus acting as a switch that triggers protein production across multiple RNA strands. Usually, plant cells do not have FTO genes or FTO equivalents in their genomes.

As per recent reports published in the international journal, '*Nature Biotechnology'*, attempts for developing transgenic rice by transferring human FTO gene into rice genome has proved to yield promising recombinants. Transgenic expression of the human FTO in rice caused threefold increase in grain yield and biomass under greenhouse conditions and twofold increase in field trials (Qiong Yu *et.al.,* 2021). These results indicate that modification of RNA m^6A methylation in rice genome is a promising strategy towards achieving better biomass and yield in transgenic rice. Similar results were obtained with FTO gene in transgenic potato also.

Mechanism of FTO Gene Expression in Transgenic Rice

Transfer of FTO gene into rice genome resulted in modification the RNA N^6-methyladenosine (m^6A) in the transgenic genome. FTO gene accounted for substantial m^6A demethylation (around 7% of demethylation in poly (A) RNA and around 35% decrease of m^6A in non-ribosomal nuclear RNA) in transgenic rice RNA. The human FTO gene regulating the demethylation process is responsible for deleting m^6A suppressor signals that would have otherwise encoded for slow growth in plants. Instead, in the early developmental stages, it acts as a response that 'triggers a switch' leading to the production of more biomass and yield, a regulatory mechanism already presents in plants.

Introduction of RNA methylase FTO gene into transgenic rice has expressed itself as enhanced proliferation of root meristem cells, tiller bud formation, photosynthetic efficiency and drought tolerance. Moreover, size of mature cells, proliferation of shoot meristem, root diameter, plant height or ploidy level was not affected. Since plant cells do not have FTO genes normally, the rice genome did not recognize the RNA methylase protein and therefore could not exert the usual strict control so that the FTO gene was free to express its effects in the transgenics (Qiong Yu *et.al.,* 2021).

Conclusion

With an objective of feeding the worlds expanding population, novel strategies to enhance food grain production has to be resorted to. Genetic modification of important crops may contribute to development of beneficial properties as increased yield, better root characteristics, enhanced photosynthetic efficiency, more tolerance to water stress, pest attacks etc. This facilitates more yield, cultivation in less ideal climates and adverse situations like extreme weather events and frequent droughts.

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Variability in Plant Pathogens

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Katravath Srinivas[1], Shaik Moizur Rahman[1]
[1]College of Agriculture, Rajendranagar, PJTSAU, Hyderabad, 500030, India.

Introduction

One of the most dynamic and significant aspects of biology is that characteristics of individuals within a species are not "fixed," i.e., they are not identical but vary from one individual to another. As a matter of fact, all individuals produced as a result of a sexual process, such as the children of one family, are expected to be different from one another and from their parents in a number of characteristics, although they retain most similarities with them and belong to the same species. This is true oomycetes and of fungi produced from sexual spores such as oospores, ascospores, and basidiospores; of parasitic higher plants produced from seeds; and of nematodes produced from fertilized eggs, as well as of cultivated plants produced from seeds. Even bacteria have mechanisms for the transfer of genetic information. As soon as individuals are formed asexually, the frequency and degree of variability amongst the progeny are reduced greatly, but even then, certain individuals among the progeny will exhibit diverse characteristics. Because of the astronomical number of individuals produced by microorganisms asexually, the total amount of variability produced by at least some microorganisms is probably as great and possibly greater than the total variability found in microorganisms reproducing sexually. This is the case in the over whelming asexual reproduction of fungi by means of conidia, zoospores, sclerotia, and uredospores, and in bacteria, mollicutes, and viruses.

Mechanisms of Variability

In host plants and in pathogens, such as most fungi, parasitic higher plants, and nematodes, which can, and usually do, reproduce by means of a sexual process, variation in the progeny is introduced primarily through segregation and recombination of genes during the meiotic division of the zygote. Bacteria too, and even viruses, exhibit variation that seems to be the result of a sexual process. In many fungi, heteroploidy and certain parasexual processes lead to variation. However, all plants and all pathogens, especially bacteria, viruses, and fungi, and probably mollicutes, can and do produce variants by means of mutations in the absence of any sexual process.

Terminology Related to Viral Variability

Variability: It is the property of an organism to change its characters from one generation to the other
Variation: When progeny of an individual display variation in characters from parents such a progeny is called a variant.
Isolate: When a virus is derived from a field or experimentally from infected host by a single isolation is known as isolate.
Variant: Isolate of the same virus that is differ in some property (Host range, transmission, serology or nucleotide sequence).
Strain: A variant of virus within a species that can be recognized by some phenotypic characteristic is known a "Strain."

Types of Variation

Variability in fungi:

a. Mutation.
b. Recombination.
c. Heterokaryosis.
d. Parasexualism.
e. Heteroploidy.

Variability in Bacteria:

a. Mutation.

b. Conjugation.
c. Transformation.
d. Transduction.

Hugo Marie de Vries

Reasons for Variability in Viruses:

a. Mutation
b. Mixed inoculation
c. Pseudo recombination
d. Heterologous Encapsidation or Genome masking
e. Long distance movement to new agro ecosystems
f. Fluctuations in vector population dynamics
g. Acquisition of novel virus like entities.

Summary Explanation for the Viral Variation

Case Study 1: Elsayed *et al*. (2018) reports that recombination has played a significant role in evolution and genetic diversity of Sugarcane yellow leaf virus (SCYLV) isolates sequenced to date. This research found that three newly sequenced Sugarcane yellow leaf virus sorghum isolates from the United States of America underwent intraspecies recombination. No statistical significance on likely progeny–parent relationships involving Sugarcane yellow leaf virus sorghum isolates were found in likely interspecies recombination with 18 members of the Luteoviridae family. Sorghum isolates deposited in the GenBank database under accession numbers KT960995, KT960996 and KT960997 were phylogenetically closely related to Sugarcane yellow leaf virus genotypes IND, CUB and CHN1, all members of phylogroup II. Networked relationships among the sorghum isolates exhibited that numerous incompatibilities arose in the sequences. These contradictory signals were possibly due to recombination, exclusively in KT960997, which was profoundly impacted by recombination. The KT960997 accession was situated on a distinct branch compared to other members of phylogroup II, suggesting that it has possibly emerged as a new genotype. Forthcoming studies on molecular evolution may reveal further insights into the adaptation capacity of these Sugarcane yellow leaf virus lineages to new environments.

Summary Of Case Study 2: Xu *et al*. (2020) cross-protection is a hopeful measure to control plant viral diseases. Reverse genetics had been freshly adopted to generate attenuated mutants that have possible in cross-protection. But research on the variability of the progeny viruses of the attenuated mutants are scarce. Sugarcane mosaic virus (SCMV) is the predominant virus inducing maize dwarf mosaic disease in China. Here, they exhibited that the substitution of arginine with isoleucine in the FRNK motif at position 184 of helper component-proteinase (HC-Pro) eliminated its RNA silencing suppression activity, considerably reduced the virulence and accumulation level of Sugarcane mosaic virus, and weakened the synergism between Sugarcane mosaic virus and maize chlorotic mottle virus. The attenuated mutant could protect maize plants from a severe infection of Sugarcane mosaic virus. Though, a spontaneous mutation of glycine at position 440 to arginine in helper component-proteinase freed the virulence and synergism with maize chlorotic mottle virus of Sugarcane mosaic virus and the RNA silencing suppression activity of helper component-proteinase. Comparable results were obtained with tobacco vein banding mosaic virus and watermelon mosaic virus. These outcomes provide novel evidence for the complementary mutation of potyviruses in maintaining the helper component-proteinase RNA silencing suppression activity and potyviral virulence and remind us of evaluating the potential risk of attenuated mutants meticulously before applying for the control of plant viral diseases via cross-protection.

Conclusion

1. Variation is one of the dynamic and significant aspect of biology of an individual.
2. Elsayed *et al*. (2018) studies shows that recombination has played a vital role in evolution and genetic diversity of Sugarcane yellow leaf virus isolates.
3. Variability maintains genetic diversity in virus populations by generating mosaic genes that help viruses overcome selection pressure and adapt to new environments and hosts.
4. Cross-protection is a auspicious measure to control plant viral diseases. Reverse genetics had been recently adopted to create attenuated mutants that have potential in cross-protection.

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A Glorious Country in a Serious Issue: Global Hunger Index and India 2021

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Dr. G. Parthasarathi[1], Dr. S. Anandha Krishnaveni[1]
[1]Teaching Assistant (Agricultural Economics), Assistant Professor (Agronomy), Institute of Agriculture, Kumulur.

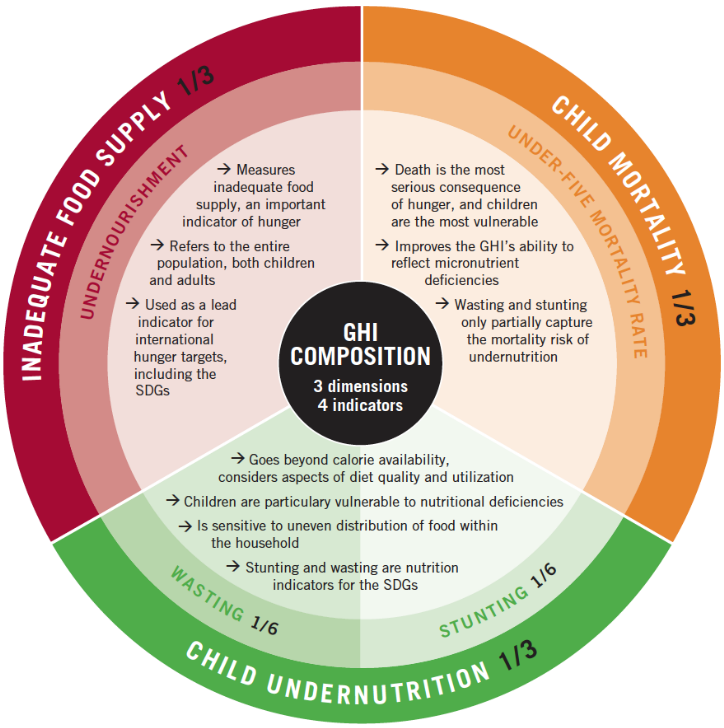
Introduction

India, with a population of over 1.3 billion, has seen tremendous growth in the past two decades. Gross Domestic Product has increased 4.5 times and per capita consumption has increased 3 times. Similarly, food grain production has increased almost 2 times. However, despite phenomenal industrial and economic growth and while India produces sufficient food to feed its population, it is unable to provide access to food to a large number of people, especially women and children. According to FAO estimates in 'The State of Food Security and Nutrition in the World, 2020 report, 189.2 million people are undernourished in India. By this measure 14% of the population is undernourished in India. Also, 51.4% of women in reproductive age between 15 to 49 years are anaemic. Further according to the report 34.7% of the children aged under five in India are stunted (too short for their age), while 20% suffer from wasting, meaning their weight is too low for their height. Malnourished children have a higher risk of death from common childhood illnesses such as diarrhea, pneumonia, and malaria. The Global Hunger Index 2020 ranks India at 94 out of 107 countries on the basis of three leading indicators -- prevalence of wasting and stunting in children under 5 years, under 5 child mortality rates, and the proportion of undernourished in the population.

Global Hunger Index (GHI)

The Global Hunger Index is a tool designed to comprehensively measure and track hunger at the global, regional, and national levels. The GHI is designed to raise awareness and understanding of the struggle against hunger, provide a means to compare the levels of hunger between countries and regions, and call attention to the areas of the world in greatest need of additional resources to eliminate hunger.

Composition of GHI



Composition of GHI (3 Dimensions and 4 Indicators)

Status of India in Global Hunger Index 2021

In the 2021 Global Hunger Index, India ranks 101st out of the 116 countries with the score of 27.5 (serious level of GHL).

Score	Level
<9.9	Low
10-19.9	Moderate
20 -34.9	Serious
35-49.9	Alarming
>50	Extremely alarming

Trend in GHI Score of India

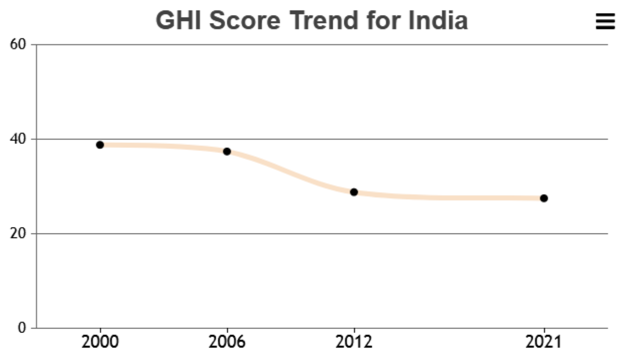


Fig.1 shows the trend in GHI score of India over the years. It shows a declining trend from 2000 to 2021. During 2000 the GHI score is 38.8 and in 2021 it is 27.5.

Conclusion

Freedom from hunger or access to adequate food and nutrition is generally perceived as a Constitutional right in India. Right to food means, at least, right of everyone to be free from hunger and malnutrition, and the right of every person to have regular and permanent access to food, which is affordable, adequate, safe and nutritious, for a healthy and active life, and culturally acceptable to the population. Another idea that has come into more recent discussion is that of food sovereignty. Food Sovereignty means the primacy of people's and community's rights to food and food production, over trade concerns. Millennium Development Goals recognizes that hunger and food insecurity are the core afflictions of poor people, and specifically sets out to halve the proportion of extremely poor and hungry people in the world. Rights based approaches, if reduced to technical and operational plans that ignore political context and power relations, will fail to be effective in promoting social justice in a sustainable way. Hence, new developmental programmes should be implemented through that the hunger issues may be eradicated in India.

Reference

https://www.globalhungerindex.org/about.html

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Feasible Technological Options for Doubling the Small Holding Farmer's Income

Article ID: 35146

Vavilla Prasad[1], Shaik Moizur Rahman[2]
[1]Department of Soil Science and Agricultural Chemistry, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad, Telangana-500030, India.
[2]Department of Entomology, College of Agriculture, Rajendranagar, PJTSAU, Hyderabad, Telangana-500030, India.

Introduction

In Indian economy, Agriculture is the most important sector. It contributes around 15% to the country's GDP during 2018-19 which declined to 17-18% during 2017-18. As per the 2011 census, it provides around 54% of the country's employment (Madhusudhan *et al.,* 2015). Therefore, Agriculture in India called as "backbone of Indian economy". In 1950-51, agriculture and allied activities contributed about 59% of the total national income which declined from 40% in 1980-81 to 15% at present (fig 1). Agriculture is the only major source of food supply as it is providing regular supply of food to huge size of population of our country. It has been estimated that about 60% of household consumption is met by agricultural products.

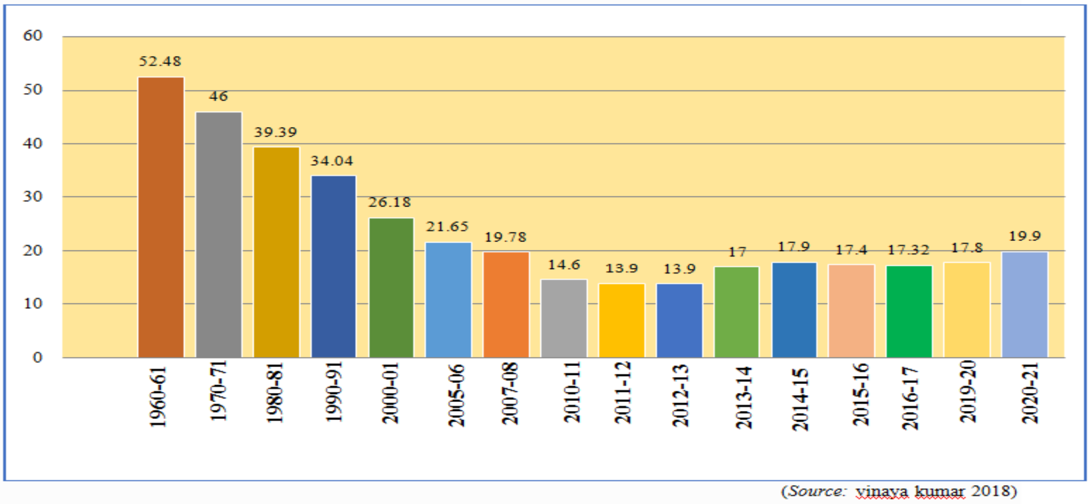

Fig 1. Trend of Agriculture and Allied Sectors Share in India's GDP

Small-hold farmers are vital for India's agriculture and rural economy. They hold about <2 ha of land accounting for 86.2% of the farmers, owning about 47.3% of the arable land (fig 2) (Bisht *et al.,* 2020)**.** Large holding farmers own between 2-10 ha of land, accounting for 13.2% of all farmers owning about 43.6% of crop area. Small farmer's contribution to national grain production was 44%. India's average operational holding size declined to 1.08 ha in 2015-16 as compared to 2010-11 (1.15 ha)**.** Thus, the small holding character of Indian agriculture is much more prominent today than even before.

A recent study by NIAP has shown that around 70% farmers annual per capita income was <15,000 Rs in the country (Chaudhari *et al.,* 2018). The Hon'ble Prime Minister, considered this as a national priority, rightly called for doubling the farmers' income by 2022. Agriculture is facing hard times currently and thus farmers are struggling to survive, make a living, sustain families and educate children by being associated in the agricultural sector. The typical Indian farmer is almost always in debt. The farmer is a perennial debtor. Once the farmer falls into debt due to crop failure or low prices of crops or malpractices of moneylenders, he can never come out of it. In fact, a large part of the liabilities of farmers is 'ancestral debt'.

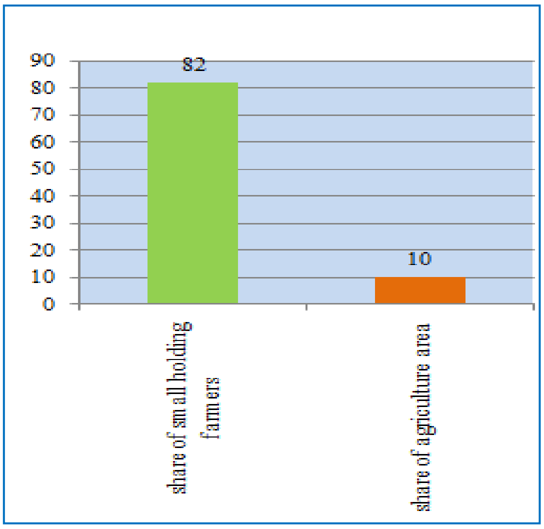

Fig 2. Share of small holding farmers to total land area

Indian soils have been used for growing crops over thousands of years without caring much for replenishing. Inadequate use of manures and fertilizers has led to depletion and exhaustion of soils resulting in their low productivity. This is a serious problem which can be solved by using more manures and fertilizers. Indiscriminate use of highly subsidized fertilizers has made the land infertile and reduced productivity. Also, MSPs for only selected crops has pushed the entire farming community to grow only these crops and thereby not allowing the market forces to decide the prices. The average annual growth rate of agriculture and allied sectors during the last decade remained at a low of 1.5% or below. Climate change is a major challenge for agriculture, food security and rural livelihoods for millions of people including the poor in India. Adverse impact will be more on small holding farmers.

Technologies for Doubling the Farmer's Income

1. Integrated farming system (IFS): IFS Approaches is only possible way out to increase the farmer's income and also full fill the need of food for increasing population. In IFS systems all agricultural activities including animal husbandry, fishery, bee keeping, goat rearing, cropping systems, fruits, vegetable and others are setup into a single unit of land and hence better recycling of resource or input occurs thereby increasing the farmer's income. Recycling of organic waste from various components is found to be more economical and save the cost of chemical fertilizers and improve the soil health as well as increase OM and microbial population for sustainable crop production. They meet the >35% of NPK requirement of soil by recycling of residues within the system and 80 to 90% of the micronutrients retain in the residue biomass can be added to the soil (Choudhary *et al.*, 2019).

2. Integrated Nutrient Management: Over the years of intensive cultivation, continuous use of chemical fertilizers and imbalanced fertilizers use, the soils of Indian subcontinent have been deficient in several nutrients and caused decrease soil organic carbon (SOC) and soil health, often leading to unsustainability of crop production system. Current annual gap between annual mining of major nutrients from the soil and inputs from the external sources is about 10Mt (Patra *et al.,* 2020). Therefore, revitalization of soil health through integrated use of chemical fertilizers, organic manures and other nutrient sources of biological origin is the best nutrient management practice. The estimated about 5Mt available nutrient (NPK) contribution through organic sources annually, which could increase to 7.75Mt by 2025. Thus, organic manures have a significant role to play in nutrient supply and improving soil health. The supplementary and complimentary use of organic manure also improves the effectiveness of mineral fertilizers (Chaudhari *et al.*, 2018).

3. Slow-Release Fertilizers/Controlled Released fertilizers: Low Nutrient Use Efficiency (NUE) is a potentially alarming situation from environmental, economic and resource conservation points of view and indicates an urgent need for improving NUE through controlled-release fertilizers which are coated/encapsulated with inorganic or organic materials that control the rate of plant nutrient release pattern and duration. These fertilizers control the release of nutrients in a pattern synchronized to meet changing crop nutrient requirements.

Anticipated benefits from slow/controlled release fertilizers (SRF/CRF) are addressed through two main processes: nutrient availability in the plant-soil system as affected by the interaction/competition between: plant roots, soil microorganisms, chemical reactions and pathways for loss; and matching nutrient release with plant demand.

4. Neem Coated Urea: Trends in crop production in the last four decades shows that N application rates increased about 15 times whereas its accumulation in grain increased only 3-4 times. At the same time nutrient recoveryby crops remaines relatively low (e.g., about 50% for N). An average 80% of nitrogen fertilizers applied in the form of urea. The normal urea is a highly soluble and volatile material and is up to 40% less efficient than NCU. NCU on the other hand, acts as a physical barrier, slowing down the process of solubility and volatility. This means it stays in the soil for longer periods strengthening its effectiveness. Studies carried out by IARI reveal the use of NCU will reduce consumption by 10 to 15% resulted in decline the cost of production.

5. Pulse based Cropping System: Pulse crops are having drought tolerant properties can be grown on marginal and wastelands. Due its short duration can fit in to the gap between two main crops and suitable crop of summer fallows of cereals and areas where rainfed agriculture is practiced. It fixes atmospheric nitrogen efficiently resulted in reduce the fertilizers input of the succeeding crops to the extent of 25-30%. They also having good green manuring properties. Thus, they improve the soil the physical, chemical and biological properties. As they require less input, less management practices and less labour requirements, the cost of cultivation of pulses is very less. Inclusion of pulse crops in the cropping system improves the economic sustainability of resource-poor farmers. It ensures an extra profit from pulses in the conventional cereal-fallow rotation, and it ensures a higher yield of subsequent crops (Adarsh *et al*., 2019).

6. Inter cropping/Mixed Cropping: Intercropping is a traditional farming practice with diversified cropping, which needs low inputs and improves the quality of the agro-ecosystem. Intensification of crops can be done spatially and temporally by the adoption of the intercropping system targeting for future needs. Intercropping has multiple benefits like high yield, environmental security, and production sustainability. In intercropping, two or more crop species are grown concurrently as they coexist for a significant part of the crop cycle and interact among themselves and agro-ecosystems. Legumes as component crops in the intercropping system play key roles in biological N fixation and soil quality improvement, additional yield output and creation of functional diversity. The maximum ground area is covered in intercropping, hence there will be a less chance of run-off, soil erosion and nutrient loss (Maitra *et al*., 2021).

7. Bio-fertilizers: Usage of biofertilizers such as *Azotobacter*, *Azospirillum, Rhizobium* for N, and phosphate solubilizing bacteria (PSB) for P, vesicular-arbuscular micorhizae (VAM) for other nutrients availability promote the growth of cereals, legumes and oil seeds better (10-25% increase) and saved 25% of NP fertilizers in crops. Bio inoculation of vegetables effected a saving of 20-25% N and P fertilizers and improve the use efficiency of N by 12-36%, P by 18-28%, K by 9-15%, S by 16-18% (Patra *et al*., 2020). Soil inoculation with *Azotobacter*, *Azospirillum* and PSB also enhance crop yields over farmers' practice by 5–10%. ICAR is also promoting the development of biofertilizers consisting of *Azospirillum*, *Azotobacter* and plant growth promoting *Rhizobacteria* (PGPR Mix I). But the current supply position in India is very low (<100,000 t), as the total expected biofertilizers demand is 1 Mt.

8. Micro-irrigation: The most concern facing in the agriculture sector is scarcity of water in light of increasing demand for industrial and drinking purposes which substantially reduces the share of available water resources to farming sector. Out of the 143 million ha (M ha) of cultivated land in India, 39Mha is irrigated by ground water, 22Mha is irrigated through canals. However, about 2/3rd of areas under cultivation in India are still depending on monsoon (Dhawan *et al*., 2017). With the need to increase productivity while saving water, micro irrigation (MI) will play a key role for the future of Indian agriculture. MI increase in water efficiency by 50 to 90%, reduce 30.5% energy consumption, Fertiliser application through MI (fertigation) save 28.5% input application, enhance crop of fruit crops (42.4%), Vegetables (52.7%), saving 31.9% irrigation cost, Increase in farmers' income up to 42%.

9. Conservation tillage: In recent years interest in conservation tillage systems get popular in response to the need to limit wind and water erosion (90% erosion reduction can be expected when using a no-till instead of intensive tillage system), promote water conservation (save water by 20 to 35%) and saving energy, especially of tractor time saved by 60 to 90% (Pradhan *et al*., 2018). If zero-tillage practice is adopted in about 3.5M ha area of Indo-Gangetic plain saves about 1 million barrel of oil. It can improve soil quality over time and reduce the soil erosion risk and reduce tillage costs. Soil health may also be improved through increased microbial activity and competition, in some cases, the potential for amelioration of plant pathogen activity and survival. Such microbial antagonism in the root zone can lead to the formation of disease-suppressive soils.

Conclusion

Agriculture is facing tough times nowadays and thus farmers are struggling to stay alive, sustain families and educate children by being associated in the agricultural sector. The biggest hurdle to all this is the absence of technological resources and education. If agriculture is a viable sector for long-term economically for the farming community, it is important to recognize that the farmers' interests are better served by a more efficient system of production, rather than high prices. For this we should create awareness among the farmers regarding various farming systems, controlled/slow release fertiliser technologies for supplement of plant nutrients in balanced proportion to meet the required amount of nutrients critical growth stages of the crop, pulse based cropping systems to reduce the supplement of fertilizers by fixing Nitrogen through legumes, conservation tillage which will reduce the cost of cultivation and soil erosion control, water conservation through micro irrigation. Further, agricultural intensification and diversification is in critical need for doubling the farmer's income.

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Hardy Fruit Trees for Orchard -Medlar (*Mespilus germanica*)

Article ID: 35147

G. Sathish[1], M. Mohanalakshmi[2]
[1]Assistant Professor (Horticulture), [2]Regional Research Station (RRS),
Tamil Nadu Agricultural University (TNAU), Vridhachalam, Cuddalore District, Tamil Nadu.

Medlar trees (*Mespilus germanica*) reach on average about 4.5m in height, and their habit (form of growth) is spreading. The leaves are long (oblong- lanceolate, in botanical terms) and downy, with dark green on the upper surface and lighter green on the lower. In autumn they become russet colored. The young twigs are also downy, and eventually turn black. The bark of the stem and branches tends o peel. The flowers are borne singly and have white or pink tinted petals, and are up to 4cm across. The fruits are mainly around with a reddish – brown, rather leathery and rough skin. At the top the fruit are indented and retains a hairy calyx and leaf like segments. The trees are virtually free of pests and diseases.

Shaping and Pruning

The trees appear to have a rather mazy branch system that, particularly in winter, may look untidy or congested at first sight; but this is actually a distinctive feature of its growth and you should not try to correct it by too much branch pruning, though any laterals that are cluttering up the tree should be removed. The regular cutting away of worn-out shoots and fruit spurs is, however, very important. Although medlar trees will crop year after without being pruned, they will become heavily congested if not kept tidy, and a major thinning operation will then be necessary. It is much better to remove potential congestion when the shoots are young, and to do this annually between mid-winter and mid spring (November and March).

Picking and Storing

Medlar are not edible in their raw state until the flesh has become very soft. Pick them from late autumn to early winter (October to early November), preferably after a sharp frost, and store them in a single layer, eye downwards. You can store them on a shelf in a cool shed, but the best method is to lay them on a bed of silver sand. Let them become thoroughly ripe ('bletted'); this is the stage at which they are ready for eating, and is normally reached within two or three weeks.

Medlar are commonly free of pests and diseases but the stored fruit is rather susceptible to a mould that starts on the stalks. If you dip the stalks in a cup of water into which two tablespoons of salt have been thoroughly mixed, this will usually give protection.

How to Use

Medlar jelly is very good, and beautifully colored. Some recipes use fruits taken straight from the trees, still firm and only just ripe. But there are old recipes that recommend using the ripe fruit, and some of these, especially those that include apple, make very fine jelly.

		
Mespilus germanica	***Mespilus germanica* Var. Dutch**	***Mespilus germanica* Var. Nottingham**

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Brimato

Article ID: 35148

Vignesh Kumar. A[1], Y. Angel[2]

[1]Assistant Professor, Deptt. of Horticulture, S. Thangapazham Agricultural College, Vasudevanallur, Tenkasi-627 758, Tamil Nadu.

[2]Assistant Professor, Deptt. of Horticulture, Kalasalingam School of Agriculture and Horticulture, Kalasalingam Academy of Research and Education, Krishnankoil, Virudhunagar-626 126, Tamil Nadu.

Innovative Technology

The inter-specific grafting has emerged as a promising tool for increasing the tolerance to biotic and abiotic stresses, besides enhancing the productivity in vegetables. The dual or multiple grafting is a new technological option, wherein, two or more than two scions of the same family are grafted together to harvest more than one vegetable from a single plant.

At ICAR-Indian Institute of Vegetable Research, Varanasi, Uttar Pradesh after a successful field demonstration of Grafted Pomato (Potato + Tomato), the Dual Grafting of Brinjal and Tomato (Brimato) was demonstrated in the field during 2020-21. The Brinjal Hybrid - Kashi Sandesh and improved cultivar of Tomato - Kashi Aman were successfully grafted into brinjal rootstock - IC 111056.

The Grafting Operation was carried out when Brinjal seedlings were 25 to 30 days old and Tomato 22 to 25 days old. The Brinjal Rootstock - IC 111056 has a tendency to develop two branches in around 5% seedlings. The Grafting was done by side / splice method, wherein, 5 to 7 MM slanting cuts (45° angle) were made both in the Rootstock and Scion. Soon after grafting, the seedlings were kept under a controlled atmospheric condition, where the temperature, humidity and light were kept at optimal for initial 5 to 7 days, then in partial shade for another 5 to 7 days. The Grafted plants were transplanted in the field 15 to 18 days after the Grafting Operation. During the early growth stage, precaution was taken to maintain the balanced growth both in Brinjal and Tomato Scions. Also shoots, if any arises below the Grafting union, were removed immediately. The fertilizers were applied at 150:60:100 Kg NPK/ha, apart from 25 Tonnes of FYM. Both the Brinjal and Tomato started fruiting in 60 to 70 days after planting.

The experimental findings revealed that about 36.0 fruits with 2.383 Kg yields were harvested in Tomato / plant, while in Brinjal 2.684 Kg yields were obtained from 9.2 Fruits / plant. The Dual Grafted Brimato Technology would be very useful for the urban and suburban areas, where the limited spaces are available for accommodating vegetables in vertical garden or pot culture over the terrace and compound. The research on commercial production of Grafted Brimato is continued at the ICAR-IIVR, Varanasi, Uttar Pradesh.

Source: ICAR-Indian Institute of Vegetable Research, Varanasi, Uttar Pradesh

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Taro Leaves - An Underutilized Green Leafy Vegetable

Article ID: 35149

Md. Naseerunnisa[1], Dr. K. Aparna[2]
[1]M. Sc Foods and Nutrition, PGRC, PJTSAU, Rajendranagar, Hyderabad.
[2]Senior Scientist and Head, MFPI-Quality control laboratory, PJTSAU, Rajendranagar, Hyderabad.

Introduction

Increasing vegetarianism and food security needs have increased plant-based research. Numerous traditional evidences also demonstrate the immense potential of locally cultivated crops in medicine and food industry. In India, fresh-food preparations form an important component of the daily diet. Green leaves are well known for the nutritional and medicinal properties and the fact that they are cheaper, increases their consumption. Colocasia spp. is an ancient green leafy vegetable cultivated throughout the humid tropical region.

Colocasia leaves have important therapeutic and nutritional properties, which makes them worthy to be placed among other green leafy vegetables like spinach. The leaves are exceptionally high in folate content, which can make them a preferred choice for pregnant and lactating women. Processing of leaves can reduce their anti-nutritional properties too.


Nutritive Information

The consumption of taro leaves is confined to the rural areas and large part of the produce is wasted. Leaves have exceptionally good nutritive composition, especially folate, iron, carotenoids, calcium and other micronutrients.

Nutrients	Composition / Quantity
Energy	177 KJ
Carbohydrates	6.7g
Protein	4.98 g
Fat	0.7g
Iron	2.25mg
Beta carotene	2895μg
Calcium	107.00mg
Zinc	0.41 mg
Potassium	648mg
Vitamin C	52 mg

Nutritional information per 100g fresh leaves

Health Benefits

There are many impressive benefits of taro leaves, particularly because of its dense vitamin and antioxidant levels.

Helps in preventing diseases: Taro leaves are an excellent source of vitamin C and polyphenols, two common antioxidant compounds. Foods containing high levels of antioxidants may help reduce potentially harmful molecules called free radicals. Thus, consuming cooked taro leaves on a regular basis may help reduce free radicals in your body, in turn aiding in disease prevention.

Boosts heart rate: In general, a diet high in nutrient-dense fruits and vegetables has been associated with improving healthy heart. Taro leaves fall into a vegetable category called dark leafy greens. They are good source of dietary nitrates which has role in maintaining healthy heart rate.

Improves eye vision: These leaves are rich in beta carotene and total carotenoids which has role in improving the eye sight. Regular consumption or including in the diet may help in preventing the diseases associated with eyes.

Weight management: Taro leaves are nutritionally dense and versatile food which fits for any. These leaves are low in carbohydrates, fat, calories and good source of fiber. Additionally, these leaves contain high amount of water content. Fiber and water content aids in maintaining healthy body weight by promoting feelings of fullness with meals.

Other potential benefits like:

a. Taro leaves can also reduce chronic inflammation and lower the blood pressure as it contains potassium and various anti-inflammatory compounds.

b. With high levels of B vitamins, these leaves are associated with the proper development of the foetal brain and strengthening the nervous system.

c. As these leaves contains high mineral levels, helps in maintaining healthier bones and teeth and a lower risk of osteoporosis.

d. In female reproductive health, these leaves are known to reduce pre-eclampsia symptoms, and can also help to reduce the appearance of stretch marks.

e. The vitamins and antioxidants in these leaves can also improve the appearance of the skin and help with withdrawal symptoms from nicotine.

f. The dietary fiber and methionine contained in taro leaves can reduce the cholesterol effectively by binding and breaking down fat and cholesterol especially triglycerides.

g. Prevents anaemia- as these leaves contain iron, helps in red blood cell formation. In addition, its vitamin C content helps to absorb the iron.

Conclusion

It has been known since ancient times that taro leaves can be used for treating various diseases like arthritis, asthma, diarrhea, skin disorders, neurological etc. Though these leaves are nutrient dense, consuming these in raw form may have some side effects. As raw leaves contain oxalate content. The oxalate content can be reduced by soaking or cooking.

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Influence of Different Factors on Carbon Dioxide (CO_2) Emission from Soil

Article ID: 35150

S Sivaranjani[1], Vijender Pal Panwar[1], Manoj Kumar[1]
[1]Forest Ecology and Climate Change Division, Forest Research Institute, New Forest - 248006, Dehradun, India.

Introduction

Carbon dioxide (CO_2) is released from soils is referred to as soil respiration (SR), soil CO_2 evolution or soil CO_2 efflux. It is a major flux in the global carbon cycle. The atmospheric CO_2 concentrations are double the pre-industrial values by the end of the 21st century. Thus, it is likely that increased CO_2 and other greenhouse gases in the atmosphere will result in a 1.4 °C to 5.8 °C increase in global air temperatures. The primary concern of researchers is the potential positive feedback between increasing temperature and enhanced soil respiration that may ultimately accelerate global warming.

CO_2 Emission from Soil

Carbon dioxide is released from the soil through soil respiration, which includes three biological processes: microbial respiration, root respiration, and faunal respiration. All the processes are taken primarily at the soil surface or within a thin upper layer where the bulk of plant residue is concentrated and one non-biological process, i.e., chemical oxidation, which could be pronounced at higher temperatures. Processes affecting the dynamics of soil carbon are presented in Figure 1. Soil microflora contributes 99% of the CO_2 arising from the decomposition of organic matter16, while the contribution of soil fauna is much less. Root respiration, however, contributes 50% of the total soil respiration.

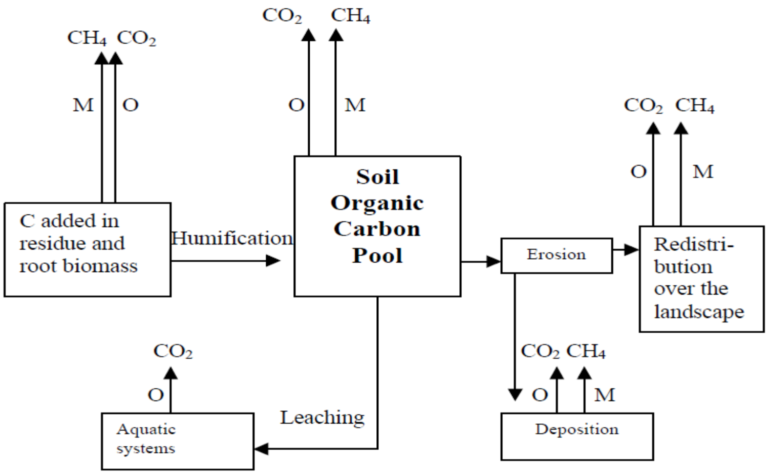

Figure 1. Processes affecting carbon dynamics (Lal, 2001)

Factors Affecting CO_2 Emission from Soil

Temperature and Moisture: The temperature has a marked effect on CO_2 evolution from the soil. There was a strong relationship between CO_2 evolution and mean daily litter temperature, and observed no CO_2 evolution at 10˚C followed by a logarithmic increase in CO_2 evolution between 20 and 40˚C; above 50˚C, it declined rapidly. At higher temperatures, partial inhibition of microbial respiration occurs, attributed to the inactivation of biological oxidation systems. Similarly, increasing soil moisture would increase CO_2 evolution up to an optimum level, which would reduce CO_2 evolution. Periodic drying and wetting of soil have a pronounced influence on CO_2 evolution. When the soil has rewetted, the activity of microbes, which were in a latent state in the dry soil, increases accompanied by the release of air trapped in the soil pores contributing to an increase in CO_2 evolution.

Soil texture: Soil texture affects the spread of microbial propagules and the growth of bacteria and fungi through the supply of air and moisture, thus affecting the formation of CO_2. Water infiltration and gas diffusion rates are also greatly influenced by soil texture and CO_2 formation and emission. It was observed that CO_2 evolution was more remarkable from clay loam soil (6.2 kg CO_2 ha^{-1} d^{-1}) than sandy soil (3.3 CO_2 kg ha^{-1} d^{-1}).

Soil pH: Hydrogen ion activity (pH) of soil has a marked effect on the growth and proliferation of soil microbes. For example, in soils with pH 3.0, 2 to 12-fold less CO_2 efflux has been observed than those at pH 4.0 (Sitaula and Bakken, 1995). It is attributed to the adverse effect of low pH on soil microbial activity, contributing to lower respiration rate and lower CO_2 evolution.

Salinity: Excess amounts of salt have adverse effects on soil's physical, chemical and microbiological processes, including C and N mineralization and enzyme activities, which are crucial for the decomposition of organic matter. Pathak and Rao (1998) recorded a progressive decrease in CO_2 evolution with the increase in soil salinity.

Atmospheric pressure: Some researchers also found that the low atmospheric pressure increased CO_2 emission from deciduous forest soil, indicating that a decrease in atmospheric pressure triggered the escape of CO_2 stored in the peat profile to the atmosphere. Some other studies have also shown that atmospheric pressure is inversely related to the emission of CO_2.

Organic manure application: The application of organic manure in the soil can increase CO_2 emissions. It is also found that soluble organic C in the soil is an immediate source of C for soil microorganisms emitting CO_2. Therefore, large quantities of organic manure added to agricultural soils every year to supply nutrients to crops may contribute significantly to CO_2 emissions.

CO_2 emission from different ecosystems: The emission of CO_2 from different ecosystems has been discussed below. However, it may be noted that an ecosystem may have a low rate of CO_2 emission but a large areal extent, and therefore, total CO_2 flux could be more.

Sequestration of C in soil: The emission of greenhouse gases has turn into a matter of great concern because of the future projections of global warming and related effects on biological life. As mentioned earlier, CO_2 is the most important of the greenhouse gases. Thus, while nations struggle to lower the greenhouse gas emissions at the source, complementary efforts must be made to enlarge the sinks of these gases.

Conclusion

Soil is one of the significant sources of atmospheric CO_2. However, it also serves as a significant sink. Several factors are influencing CO_2 production and emission from the soil. These include inherent properties of the soil like texture, moisture, pH and salinity, which influence CO_2 production through soil microbial activity and root respiration. Besides these, external factors (seasonal effect and atmospheric pressure) and manipulation of soil environmental conditions also affect CO_2 production and emission.

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Pigeon Pea Sterility Mosaic Virus: A Devastating Virus of Pigeon Pea

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Parmar Darshan M.[1], Patel Jaina V.[1]
[1]Department of Plant Pathology, B. A. College of Agriculture, Anand Agricultural University, Anand-388110.

Pigeon pea [*Cajanus cajan* (L.) Millsp.] is a second major pulse crop grown in India and South Asian countries (Jones *et al.,* 2004). It is a perennial and short duration crop belonging to the family *Fabaceae* and native to South Asia. The crop is being affected by 50 diseases, in mild to severe form. Out of these, Sterility Mosaic Disease (SMD) causes greater yield loss than any other disease affecting pigeon pea in India. Infection of SMD occurs at an early stage *i.e.,* less than 45-day old plants, which leads to 95-100 per cent yield loss (Manjunatha *et al*., 2021).

Causal Organism

Sterility mosaic disease is caused by *Pigeon pea sterility mosaic virus* (PPSMV) belongs to the order Bunyavirales, family *Fimoviridae* and genus Emaravirus. PPSMV is a segmented, negative-sense and has a single-stranded RNA genome with double membrane-bound virus-like particles of 80-200 nm in diameter. It is transmitted in a semi-persistent manner by an eriophyid mite *Aceria cajani* Channabassavanna (*Acari*: Arthropoda) and are very small, spindle-shaped, yellow to pink in colour and can be visible under a stereo binocular (40X) microscope. *Aceria cajani* has a short cheliceral stylet, due to the short stylet length of the mite; the feeding causes no observable damage to the crop (Manjunatha *et al*., 2021).

Symptomatology

The diseased plant shows noticeable mosaic and sterile (malformed or no flowers) symptoms; hence the name of the disease is sterility mosaic. The symptoms of the disease depend on the nature of the genotype. Three types of symptoms commonly observed (i) Complete sterility: leaflets with severe mosaic, plants deprived of flowers and pods during early infection, *i.e*., initial 45 days (ii) Partial sterility: mild mosaic in few leaflets and such leaflets are devoid of flowers and pods if the plant infects beyond 45 days after sowing (iii) Ringspot: leaves with green islands bordered by a chlorotic halo which diminish as the plants mature (Reddy *et al.,* 1998).

Epidemiology

Reddy *et al.,* (1990) observed the role of wind in transferring the inoculums and reported that disease can spread up to 2 km downwind from the source of inoculum but the spread in an upwind direction was very limited (<200 m) confirming that wind assists in mite dispersal. Dipshikha *et al.,* (2013) reported that temperature, relative humidity and rainfall are the main factors affecting the mite population. Shade and humidity encourage mite multiplication; however, heavy rainfall is unfavourable for its multiplication.

Management

Cultural method and host plant resistance: The use of resistant variety and timely sowing of the crop are effective cultural methods to manage SMD. Destruction of mite-infested plants at an early stage of the crop, sowing new crops away from perennial pigeon pea, the rotation of pigeon pea with other crops to reduce vector population. Bhaskar (2016) found that ICPL-87119, ICPL-2376, PT-4-307, CORG-9701, BSMR-736, GRG-811 and BSMR-853 are resistant genotypes to SMD. Pallavi *et al.,* (2020) recorded the highest SMD incidence and mite population in the crop sown in June than those in other months at 90 DAS. In host plant resistance, antixenosis mechanism is very effective where the insects or mites starve and die (Painter, 1951). Manjunatha *et al.,* (2018) found the higher thickness of cuticle, epidermis and less number and length of leaf hairs in SMD resistant cultivar.

Chemical method: Rajeswari *et al.,* (2016) reported that two sprays of fenazaquin 10 EC, 0.1% at 30 days after sowing (DAS) and 15 days after the first spray accounted for 80.9 per cent reduction in disease as compared to control. Spraying of propargite 57 EC, 0.1% at 25 and 40 DAS observed considerably lowest SMD incidence (7.72%) with the highest yield of 875 kg/ha (Maurya *et al.,* 2017). Manjunatha *et al*., (2018) found that wettable sulphur 80 WP (3 g/l) + propargite 57 EC (1.5 ml/l) in combination and wettable sulphur 80 WP (3 g/l) alone was very effective in reducing cent per cent mite population.

Conclusion

Sterility mosaic disease (SMD) is aptly known as 'green plague' which remained a mystery for over 70 years, was resolved with the discovery of *Pigeon pea sterility mosaic virus* (PPSMV) in 1999 and its complete genome sequence in 2014. The PPSMV belonging to the newly established genus *Emaravirus*, containing multipartite and negatively oriented single-stranded RNA genomes and is transmitted by *Aceria cajani*, an eriophyid mite in a semi-persistent manner. The monitoring of mite population on the leaves and stages of acaricides application are crucial to prevent the secondary spread of the virus. The better ways to reduce production loss by preventing mite vector multiplication in the field by adopting prophylactic spray of acaricides (wettable sulphur 80 WP, propargite 57 EC and fenazaquin 10 EC) and growing of resistant/tolerant varieties.

Future Thrust

Need to…

1. Study prevalence of PPSMV, virus strain characterization and identification of resistant sources against SMD and its resistance mechanism for disease control
2. Understand and target virus-mite molecular interactions which are required for the development of novel strategies to control SMD.
3. Discourse the disease through studies on biology and epidemiology of mite vector and its occurrence, development of consistent phenotyping techniques to identify the genetic of resistance to mite and virus

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Metabolism of Insecticides

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Thakur Mandar Vijay[1], Kallem Manish Reddy[2], Dinesh Rai[3]
[1&2]Department of Entomology, Post Graduate College of Agriculture,
[3]Department of Plant Pathology, Post Graduate College of Agriculture,
Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar.

Introduction

When an insecticide is applied on any organism i.e., plant or animal, it undergoes some chemical changes resulting in the formation of new products called as metabolites and the process is known as metabolism. The metabolite is a greek word which means changes. All insecticides get metabolised 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., spices, strain, age, sex etc., the time and the environment factors. If changes take place at more than one point of the molecules 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 compounds.

The metabolism of organic insecticides can be categorized in to two broad groups i.e., activation and detoxification.

1. Activation: The metabolic compound that converts an inactive compound to an active compound or an active compound to another active compound. In some cases, more than one active compound may be formed.

2. Detoxification: The metabolic reaction that converts the compound in to on toxic compounds.

Enzymes Involved in Metabolism

1. Esterases: These are the enzymes which hydrolyze carboxylic and phosphorus esters. Thus, esterases abbreviated as est include the aliesterase, phosphoryl phosphatises, paraoxonase and other enzymes hydrolysing phosphorus esters. It also includes the diesterase.

2. Mixed function oxidase or mfo system: This utilizes NADPH as a cofactor in enzymatic of molecular oxygen for eventual insertion into the substrate. In mammals, these enzymes reside largely in the endoplasmic reticulum or microsomal fraction of liver while in insects they are concentrated in the fat body, intestine and malpighian tubules. Plants contain oxidase system comparable to animal mfo system.

Metabolic Pathways

1. Phase I reactions:

a. Oxidation: Oxidation is taken place through mfo in which one atom of a molecules of oxygen is reduced to water while the other is used to oxidise the substrate.

b. Reduction: Halogen is replaced by hydrogen atom. Conversion of DDT into DDD is the example of this type of reaction.

c. Hydrolytic processes: By the action of esterase enzymes the positively on the phosphorus atom of the insecticides is reduced. Organophosphates can be hydrolysed by phosphates, carboxysterases or carboxyamidases.

d. Glutathione mediated reaction: In the metabolic process of insecticides, glutathione is utilized either in a purely catalytic manner like conversion of DDT to DDE or consumed by the direct binding to the substrate.

2. Phase II reactions:

a. Glutathion conjugation: The harmful electrophilic compounds are conjugated with GSH (reduced glutathione) and other nucleophilic centres like proteins and nucleic acids are protected. Example- Ethyl parathion may be de-ethylated to form desethyl parathion or de-aryla to form dimethyl phosphoric acid.

b. Glucoside conjugation: The insecticides or their metabolism combine with glucose to form conjugates.

c. Amino acid conjugation: This occurs by the activation of the insecticidal acid through the enzyme requiring ATP and the condensation thereafter with endogenous amino acid.

Metabolism of Oregano Chlorine Insecticides

1. DDT- DDT gets converted into DDE in housefly due to dehydrochlorinase enzymes. In Drosophila the metabolism of DDT to kelthene (Dicofol) is taken place due to oxidation. The conversion of DDT to P-P-dichlorobenzophenone (DBP) has been reported in fruit fly and cockroaches. The principal metabolite of DDT in vertebrates is DDA which gets excreted in urine and faeces. The metabolism of DDT to DDD is taken place in plants. DDD has also been detected in insects and mammals.

2. Lindane: In mammals lindane is mainly metabolized by various intermediate stages to 1,2,4-trichlorobenzene which is further converted to isomeric trichlorophenols. Excretion occurs after formation of glucoronate derivative. Due to enzymes present in insects, lindane is converted into water soluble metabolites.

3. Aldrin: By enzymatic oxidation aldrin is converted to its epoxide, dieldrin in mammals, insects, microorganisms and plants which is more toxic in nature. Aldrin is also converted in to photoaldrin and dieldrin to photodieldrin.

4. Heptachlor: Heptachlor is converted to its epoxide in insects and mammals. Heptachlor epoxide is more toxic than heptachlor itself. In mammals, ultimately hydrophilic metabolites are formed. Soil micro-organisms degrade heptachlor principally to 1-hydroxychlordene.

5. Chlordane: Chlordane is converted in hydrophilic metabolites through dehydrohalogenation and hydroxylation steps in insects and mammals which are excreted.

6. Endrin: Endrin is converted mainly to hydrophilic metabolites in mammals and insects. The half-cage ketone is reported a metabolite of endrin in house flies.

7. Endosulfan: The conversion of endosulfan into endosulfan sulphate has been reported in plants and mice. In mice it is stored in fat and excreted in feces. Due to oxidation endosulfan is converted into endosulfan sulphate.

Metabolism of Organophosphate Insecticide

1. Dichlorvos: Dichlorvos is the example of phosphate group. It is direct inhibitor and does not require activation. Breakdown of dichlorvos in animal may be of two types. One involves esterases which cleave the product to O, O-dimethyl phosphoric acid and dichloroacetaldehyde; which on oxidation converted into dichloro ethanol acid, whereas on reduction to dichloroethanol which further converted into glucuronide. The second reaction is demethylation requiring glutathione and a S-alkyl tranferase forming dimethyl DDVP, which is converted into methyl phosphoric acid and futher to in organic phosphoric acid.

2. Parathion: Parathion is a phosphorothionate ester and a poor inhibitor, requiring activation, due to which P=S is converted into P=O, forming paraoxon. The activation is carried out by MFO.

3. Malathion: The conversion of malathion to malaoxon has been seen in insects, mammals and plants. The malaoxon is further metabolised to dimethyl thiophosphoric acid and then to phosphoric acid. Due to dealkylation malathion is converted into desmethyl malathion and then to phosphoric acid. The toxicity of malathion to insect is due to higher production of malaoxon and lower activity of carboxyesterase.

4. Dimethoate: Dimethoate is hydrolysed by carboxyamidase to dimethoate acid. Dimethoate is also hydrolysed to phosphoric acid derivatives.

5. Demeton: Thiono isomer of demeton oxidised to phosphate, thionosulfoxide, thiono-sulfone, phosphate sulfoxide, phosphate sulfone and thiono isomer of it to thiolosulfoxide and thio sulfone. Thus, the principal metabolic pathway for both isomers is the oxidation of 2 – ethylthio ether to the sulfoxide and sulfone, these two metabolites are more active as cholinesterase inhibitors.

6. Phorate Phorate is converted into sulfoxide and sulfone in plants and animals due to activation reaction. Due to these metabolites the cholinesterase activity is increased. Sulfoxide and sulfone are further converted into phosphoric acid and sulfone derivative of this alcohol due to phosphatise.

7. Disyston: Disyston is also a thioether derivatives of phosphorodithioate therefore, the mode of metabolism is the same as that of phorate.

Metabolism of Carbamate Insecticides

1. Carbaryl: Carbaryl is monomethyl carbamate. Carbaryl is hydrolysed to 1-napthol, Co2 and methylamine. This reaction is catalyzed by plasma albumin among other proteins. In most cases the major metabolic pathways appear to involve oxidation or hydroxylation by mfo system.Carbaryl metabolism from soil by microorganisms has been reported. A strain of *Achromobacter* metabolizes carbaryl to catechol, pyruvate and hydroquinone.

2. Carbofuran: House fly metabolizes the carbofuran by oxidation to the 3-hydroxy derivative followed by conjugation of this metabolite as a glucoside. Other metabolites are 3 hydroxy-N hydroxymethyl carbofuran, N-hydroxymethyl carbofuran and 3 keto carbofuran. The primary metabolites of carbofuran isolated from mice were 3-hydroxy carbofuran and a small amount of 3-keto carbofuran.

3. Aldicarb: The metabolism of aldicarb in plants and animals is different from other carbamate insecticides that it first gets activated and then detoxification takes place. Since it is thioether oxidation is followed by detoxification. The thioether, moiety of the aldicarb is rapidly oxidised to sulfoxide and slowly to sulfone. In plants and insects, the aldicarb is metabolised to aldicarb sulfoxide which is relatively stable.

4. Methomyl: In rats and plants methomyl is degraded to carbondioxide and acetonitrile. In soils, the degradation pathway is even simple wherein carbondioxide is the only metabolite formed from methomyl.

Cotton: Nutritional Deficiencies and Physiological Disorders

Article ID: 35153

B. Rakavi[1], S. Anandakumar[2]
[1]Department of Crop Physiology, [2]Depatment of Agricultural Microbiology,
Tamil Nadu Agricultural University, Coimbatore – 641 003.

Introduction

Cotton, known as "the King of fibres", continues to be the predominant fibre in the Indian textile industry, despite stiff competition from the man-made synthetic fibres. It assumes a place of pride in Indian economy, as cotton production, processing and trade in cotton goods provide employment to about 60 million people in our country. Further, the export of raw cotton, yarn, textile, garments, cotton seed cake, oil and other byproducts earn valuable foreign exchange. In India, cotton is grown in three agro climatic zones, northern zone where cotton is raised entirely under irrigation, central and south zones where it is predominantly a rainfed crop. Cotton provides employment to several million people in cultivation, trade, processing, manufacturing and marketing, sustaining directly or indirectly about 10 per cent of the population of India (Status paper of Indian cotton, 2019). A minimum temperature of 15ºC is required for better germination at field conditions. The optimum temperature for vegetative growth is 21-27ºC & it can tolerate temperature to the extent of 43ºC but temperature below 21ºC is detrimental to the crop. Cotton grows best in clay loam soil. As a glycophyte, cotton shows higher tolerance to abiotic stresses than other major crops. According to a press release from the United States Department of Agriculture (USDA), cotton production is expected to decline in the upcoming years due to nutritional deficiencies and physiological disorders. This paper provides the information about nutrient deficiencies affecting cotton production and some of the mitigation measures to withstand the constraints.

Nutrient Deficiencies in Cotton

Nitrogen: Nitrogen is an essential constituent of aminoacids, nucleic acids, chlorophyll and protoplasm.

Deficiency symptoms: N deficiency symptoms first appear on the older leaves at the bottom of the plant. N is a mobile element and is rapidly translocated to the young developing parts. Early season deficiency results in plants with pale green yellowish leaves and stunted growth. Late season deficiency leads to reduced boll retention. Plants suffering from N deficiency, mature earlier and vegetative growth is shortened.

Correction Measure: Urea 1% foliar spray or DAP 2% can control this deficiency

Phosphorus: It is the second most commonly applied fertilizer nutrient. The plant takes up P as inorganic anion. The form of uptake is largely governed by pH.

Deficiency Symptoms: Dark green stunted plants, delay in blooming and fruiting. Small leaves and the symptoms first appear on the lower or older leaves and progress upward on the stalk.

Correction Measure: Foliar application of 2% DAP

Potassium: K plays an important role in fibre development and the turgor driven expansion of fibre cells ultimately determines the fibre length.

Deficiency Symptoms: Older leaves are chlorotic, droopy and have yellow spots between the veins the edges turn yellow then brown curt downward and die.

Correction Measure: Foliar spray of 1 % KCl

Calcium: Calcium is the second of the secondary nutrients; it is readily transported to the root surfaces by mass flow.

Deficiency Symptoms: Large plants and few fruiting forms. Crinkle leaf and poor root growth.

Correction Measure: Soil application of gypsum @ 50 kg/ha.

Magnesium: The most important function of Mg is its occurence in the centre of the chlorophyll molecule. It plays an important role in N metabolism. Proportion of protein-N decreases in Mg deficient crop caused by the dissociation of the ribosomes. Mg helps in translocation of cellulose and determines fibre quality.

Deficiency Symptoms: Presence of high Ca may induce Mg deficiency leading to "reddening" of leaves. In contrast to Ca, deficiency symptoms are initially observed in the older leaves. The reddening occurs due to reduced photosynthetic activity. Sometimes the Mg deficiency is confused with natural ageing late in the season. Leaf cupping and interveinal chlorosis,

Correction Measure: Foliar spray of $MgSO_4$ @ 1 %

Sulphur: Constituent of aminoacids (cysteine and methionine), coenzyme A, thiamine and biotin.

Deficiency Symptoms: The plants are small and spindly with short, slender stalks. Deficiency is first seen on upper young leaves. Leaves first turn to light green to light yellow followed by pronounced yellowing.

Correction Measure: Foliar spray of $MgSO_4$ @ 1 %

Iron: It plays an important role in photosynthesis, nitrate and sulphate assimilation and synthesis of chlorophyll.

Deficiency symptoms: Interveinal chlorosis of young leaves which progresses over entire leaf. In severe cases leaves turn completely white.

Correction Measure: Soil application of $FeSO_4$ @ 5 kg/ha or foliar spray of 0.5% $FeSO_4$.

Boron: Important for assimilate translocation during reproductive parts.

Deficiency Symptoms: With progress in deficiency, the terminal growing point dies, short leaf petioles with dark green rings, excessive shedding of buds and young bolls, bolls dry and fall young leaves become thick, brittle with water spots.

Correction Measure: Soil application of borax 0.5 kg/ha or foliar spray of borax 0.2% (Rajendran *et al.,* 2010)

Manganese: Manganese is required in minute quantity for optimum production of cotton. It is associated with iron movement within the plant which in turn helps in the synthesis of chlorophyll.

Deficiency Symptoms: Yellowing of cotton leaves at top of plant following irrigation, they become puckered, mottled, and partially chlorotic and distorted in early stages with necrotic lesions subsequently appearing along the veins.

Correction Measure: Soil application of $FeSO_4$ @ 5 kg/ha or foliar spray of 0.5% $FeSO_4$.

Zinc: Zinc is a metal component of several enzymes (carbonic anhydrase). It is also involved in the auxin production and synthesis of RNA. Zinc deficiency has become a limiting factor in crop production now-a-days.

Deficiency Symptoms: The leaves become thick and brittle with their margins cupped upwards. Squares and flowers that are formed tend to shed.

Correction Measure: Soil application of $ZnSO_4$ 5 kg/ha or foliar application of $ZnSO_4$ 1% (*Source*: CICR, Technical bulletian, 2006 and TNAU Agri Portal, 2021).

Physiological Disorders

Physiological disorders appear in cotton as a reflex of plant response to environmental stresses, nutritional imbalances and chemical factors.

Bud and boll shedding: Due to insufficient light, production of key hormones like auxin in the leaf is also limited inducing a hormonal imbalance in the plant causing bud and boll shedding.

Management: Under such conditions, foliar application of 1% urea or 2% diammonium phosphate (dap) during flowering at 10-15 days interval was found beneficial.

Leaf reddening: Leaf reddening in cotton is also known as red leaf disease (lalpatti). This disorder is an outcome of interaction of location, variety, environmental condition and nitrogen supply. Apperance of red leaf symptom is primarily, due to the accumulation of anthocyanin pigment. Leaf reddening may occur at any growth stage of the crop. It is generally observed 90 days after sowing particularly where cotton is grown in red or laterite soils.

Management: Adjustment of sowing time for enabling the crop to skip over the adverse environmental condition during boll development stage. Magnesium sulphate at 0.5% can be sprayed. Leaf reddening incidence due to sucking pests may be overcome by spraying recommended insecticides

Bad boll opening: Bad boll opening is also called as Tirak. Symptoms are premature and improper cracking of bolls, instead of normal fluffy opening. Soil with subsoil salinity, light sandy soil, nitrogen deficiency, prevalence of low humidity, warm and dry weather during fruiting period, low moisture and nutrient availability during boll formation. The capsule wall of the bolls become tight and does not open completely. The affected bolls may turn black in color with time. The fibre as well as seed quality are affected.

Management: Adjusting sowing dates so that the boll formation stage is not affected by any environmental stress or nutritional deficiency, appropriate nitrogen management at critical growth stages, frequent irrigations to reduce effect of subsoil salinity/ alkalinity, timely application of nitrogen in light sandy soil, use of growth retardant to check excessive vegetative growth

Crinkle leaf: Due to high amount of magnesium in waterlogged soil and calcium deficiency leads to development of chlorosis, distortion of leaves and crinkled leaf symptoms. Initially the symptoms are seen in the young leaves and gradually spread to the lower canopy.

Management: Gympsum application can neutralize manganese toxicity.

Conclusion

Cotton research has witnessed many progressive developments over the past half a century to address the above-mentioned challenges and limitations. The base for everything lies within the physiological mechanisms of cotton plant. One of the tools used in reducing environmental risks and increasing the yield is cultivar development through physiological breeding and genetics. Exogenous application of many growth regulators and nutrients helps the plants to cope with varying disorders and deficiencies. Cotton researchers worldwide have initiated and performed largely coordinated research projects in every physiological aspect of cotton science. These efforts have greatly accelerated cotton research worldwide and helped to address the key issues of cotton production and farming.

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Jute Quality Breeding

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Thribhuvan R[1], Ravikiran K T[2], J. K. Meena[1], Kumar Nishant Chourasia[1]
[1]Crop Improvement Division, ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore-700121 (West Bengal).
[2]Regional research station, ICAR-Central Salinity Research Institute, Lucknow – 226002 (Uttar Pradesh).

Jute is one of the popular fibre yielding crops of India. India is the largest producer of Jute across the world and its centre of origin is stipulated to be in India since its cultivation and utilization dates to Indus valley civilization. Recently, there is a renewed interest on jute fibre due to its diversified end use and ecofriendly nature. Since jute fibre can be blended with different fibres like viscose, polyester and cotton for diversified textile and garment industries, several attributes of jute fibre including fibre strength, fibre fineness and lignin content are receiving attention of jute breeders. In order to compete with synthetic fibers on the world market, jute fiber yields and quality must be improved further. This has necessitated additional genetic improvement in jute quality. It is also recognized that jute fiber yield and quality are polygenic characteristics with a high amount of genotype–environment interaction, making their improvement through conventional breeding highly challenging. Even though jute is being farmed for generations, considerable progress in crop development has not been made. Some of the bottlenecks to jute crop improvement can be as follows:

1. Strong sexual incompatibility exists between the two cultivated species, as well as between the cultivated species and the majority of their wild relatives.
2. The cultivated jute cultivars have a limited genetic base.
3. Most elite jute cultivars have photoperiod sensitivity.
4. Challenges caused by early flowering, which makes it difficult to produce high-quality fiber and seeds from the same plant.
5. Jute is susceptible to a variety of biotic and abiotic stresses, resulting in a large production loss for this crop each year.

As a result, effort must be made to improve fiber properties by the use of contemporary biotechnological techniques such as plant genetic transformation, which would broaden the crop's genetic base by inserting particular genes for desirable traits. This, in turn, would play a critical role in improving jute quality and yield in resource-constrained farming situations.

Conventional Breeding

Breeders often use introduction, selection, and sexual hybridization to develop improved jute varieties with good agronomic traits. According to data on the major jute (*Corchorus capsularis*) cultivars gathered in India since independence, intraspecific hybridization was the primary approach for breeding new cultivars. Years of research and development in India resulted in the production of the JRC-321 (*C. capsularis*) with the finest fiber of 1.5 tex. Also, better *C. olitorius* jute cultivars such as JRO-524 (Navin) and JRO-204 (Suren) were developed and released, occupying most of the farmed area. Presently interspecific hybridizations are pursued with the aim of transferring fine fibre traits from the donor (wild species) to cultivated jute.

Fineness can also be transferred from cultivated *C. capsularis* to *C. olitorius* which is having higher yield potential than the latter. Conventional single-plant pedigree breeding, which depends on indirect selection by correlated yield traits has traditionally been used to increase jute yield. However, bast fibre quality attributes such as tensile strength and fibre fineness are complex traits which are under polygenic regulation, with low-to-medium heritability. This causes a severe taxing on the genetic advancement in selection for physical fibre quality traits making it excruciatingly slow over the years. In general, conventional breeding systems in jute have been insufficient due to jute's restricted and small gene pool, lack of compatible breeding resources and strong sexual incompatibility.

Molecular Breeding

A number of DNA markers have been developed in jute over the last decade, but most of the early marker systems developed were more of an academic interest than of any practical significance. To date, the major groups of DNA markers formed and validated in jute are as follows: AFLP, CBDP, EST-SSR, ISSR, RAPD, RAD, SCAR, SRAP, STMS, SSR and SNPs.

Despite the existence of a large number of DNA markers, some of which have a high degree of PIC and comparable cross-species transferability, their use in the detection of quantitative trait loci (QTL) for major agronomic traits in jute has been restricted over the last decade or so, though attempts have been made to use them for marking traits of agronomic significance. Till date there are only six QTL publications for *Corchorus spp*. QTL discovery for major agronomic characteristics, particularly complex bast fibre quality characteristics, proved difficult, if not impossible, in jute.

Because of the prevalence of low-density maps, marker-assisted selection could not be used in jute at first. However, high-density *C. olitorius* linkage maps using microsatellites and restriction site-associated DNA (RAD) markers have recently been developed. Jute population analysis based on RAD-SNPs can also provide a detailed picture of a population's genetic differentiation and structure. Current findings based on RAD-SNP analysis of 221 fiber-type *C. olitorius* was able to identify its population structure and revealed two unique ancestral subpopulations of *C. olitorius* (African and Indian). This might be important in the future for the research of jute genetics and the MAS of superior jute cultivars.

The "omics" era of scientific study (genomics, transcriptomics, proteomics, metabolomics) gives fresh hints for targeted biotechnology solutions to increase jute fibre quality. Islam *et al*. (2017) published whole genome sequences of both cultivated species of jute, which provide critical resources. The potential to compare genotypes using large-scale, relatively high-throughput approaches provides a potent discovery framework for genes and other mechanisms governing jute fibre morphogenesis and quality.

Given the difficulty of regenerating jute transformants and the logistical hurdles of comparing a transgenic family to transgenic controls, future genetic engineering targets should be chosen with caution. Targeted genome editing technologies like Crispr/Cas9, meganucleases, and TALENs have the potential to simplify this process by allowing multiple traits to be stacked within a single locus, making it easier to modify various elements of fibre formation at the same time and easing multi-trait introgression into contemporary jute cultivars.

Although jute has trailed behind all other major crops in the development and use of genomic resources, the recent devaluation of genome sizes in *Corchorus spp.* has resulted in a rush of initiatives into genomics or high-throughput next-generation sequencing (NGS) technologies at cheap rates which will play major role in dissecting the quality traits of jute.

Future Possibilities and Prospects

Future jute research should focus on the following chosen fields based on existing developments in research interest and commercial demand for high-quality fibre.

1. Exploring the distinct fibre quality of wild jute
2. Jute with low lignin content for industrial use
3. A more efficient genetic transformation technique for jute.
4. Transgenic jute.

Despite sustained attempts over several years, no meaningful genetic gain in jute selection for fibre quality attributes has been obtained. The collection and use of jute germplasm have considerably boosted productivity, which should be investigated further in order to improve desired features and meet market demands; As a result, there is an urgent need to introduce trait-specific germplasm.

Furthermore, fibre qualities are becoming increasingly essential because of their global influence on textile manufacturing, processing, and end-product value. Fiber quality and uniformity improvements are predicted to include modifications in fibre initiation, low lignin content, elongation, diameter, maturity, strength, and plant architecture.

These improvements will be implemented using knowledge gathered through the development of core collections, genes imparting agronomically important traits, and transcriptome expression at crucial periods for fibre production. Incredibly, extensive genome sequencing for *C. olitorius* and C. *capsularis* has propelled jute development into the genomic age. The advancement of germplasm variomes, breeding genomics, and cultivation genomics will result in jute quality improvement revolution.

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Food Prices: Ever Increasing or Never Decreasing?

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Bindu H A[1], Harish Kumar H R[1], Kavita Hurakadli[1]
[1]Ph.D Scholars, Department of Agricultural Economics, College of Agriculture, Bangalore, University of Agricultural Sciences, Bangalore.

Summary

Inflation is most often found in every type of economy because of the increasing population and their growing demand for the goods and services. Food inflation is one of the important components of aggregate inflation as there is greater weightage for it while measuring various indices. India has witnessed running inflation in the economy during some years since independence. The economy during 2012 to 2018 has observed a better sustained inflation and inflation in India averaged about 6.37 per cent from year 2012 to 2018; whereas, in case of food inflation it was 6.15 per cent for the same period. The various causes of food inflation are increase in demand, demand-supply mismatch, increase in wage rates, MSP, global food inflation etc. and it affects income, production, fiscal deficit. India has also experienced period of high inflation in the earlier past but has sustained in the recent past. Thus, food inflation accruing a major share, determines the aggregate inflation which further governs the price stability in the economy.

Introduction

Inflation is continuous and constant rise in the general price level of goods and services over a period of time. It causes fall in real income of the people entailing that the people are able to buy less goods and services with the same money income. The rapid rise in food prices has been a burden on the poor. In developing countries, this section spends an inordinately high amount of their income on food thus, a sustained increase in food prices adversely impact the welfare of poor's', as they spend larger part of earnings on food and would not be in a position to direct the additional resources for consumption of food in order to offset the effect of rising prices. In many countries food price inflation is higher than aggregate inflation and contributes to underlying inflationary pressures. In a developing country like India, the level of inflation is a concern for Government, businesses and consumers by way that the increase in price will directly affect cost of living, if not compensated with higher income and affects economy in terms of price mechanism, investment, savings etc.

Wholesale inflation, retail inflation, headline inflation and core inflation represent inflation in their respective basket of goods and services or in the sectors of the economy and food inflation represents the relative rise or fall in the prices of food items either raw or processed. Wholesale Price Index (WPI) and Consumer Price Index (CPI) are the two indices used to measure food inflation in India along with GDP deflator.

Inflation and Food Inflation in India

For the period, 1969 to 2013 the average inflation rate was 7.7 per cent, but it was 34.7 per cent high during 1974 because of the oil crisis (3 times increase in crude oil prices) and rising cost of the 1971 war which was funded with deficit financing. During 1976, India witnessed negative inflation of -11.37 per cent because inventories of commodities were liquidated which increased supply and high inflation in preceding years. Inflation in India averaged about 6.37 per cent from year 2012 to 2018; whereas, in case of food inflation it was 6.15 per cent for the same period. Annual consumer inflation in India declined to 2.19 percent in December of 2018 from 2.33 percent in November, matching market expectations of 2.2 percent. It is the lowest inflation rate since June of 2017 as food prices continued to decline and inflation eased for clothing, housing and fuel. It also reached an all-time high of 12.17 percent in November of 2013 and a record low of 1.54 percent in June of 2017. Sustained food inflation is observed in India since 2014 to 2018 except during July 2017 where inflation was negative (deflation) because of the post-demonetization effect which made distress sales by farmers accompanied by bumper harvest which caused prices to decline; and -2.61 per cent deflation was found in November 2018 because of surge in agricultural production especially of vegetables and pulses.

However, there is no inflation rate which can be considered as ideal for any country or is based on the recommendations or the predictions. The actual ideal rate depends on the ability of a country to withstand the price rise when they are higher or whether it can remunerate when they are lower. So, the ideal range of inflation would be where, the consumers have the ability to make purchase at that particular range and the one which would yield the farmer-producer the remunerative or profitable returns.

Causes and Impacts of Food Inflation

The food inflation contributes about one-third to the overall inflation. The major drivers of food inflation are vegetables, milk and its products, pulses as they have higher weightage in the index. Increase in demand for protein rich foods, demand-supply mismatch, increase in wage rates, MSP (Minimum Support Price) and global food inflation are the major drivers responsible for food inflation. Speculation/hoarding, increase in fuel prices, export of food items, high market margin, procurement by Government are the others factors causing food inflation. Food inflation has impact on non-food inflation by way of increase in prices which leads to cascading effect on the economy; induces bargaining by workers to increase wages causing rise in cost of production and thereby prices of non-food articles. Food inflation can raise aggregate inflation substantially as food constitutes a significant share of the consumption basket. Aggregate inflation also increases through second round effect *via* the rise in non-food inflation caused by the rise in food inflation. Inequality in economy is found because poor will be left with less income but food inflation encourages producers and traders. At the time of high inflation, the Government increases food subsidy to overcome the situations, which further increases fiscal deficit and becomes a concern for the economy.

Conclusion

In the earlier past, India has seen a period of high inflation, to a large extent driven by persistently-high food inflation. Domestic food demand and supply factors underpin India's food price dynamics. Therefore, tackling food inflation is the key priority of the Government and policy makers as it impacts the weaker sections of the society. The issue should be tackled by addressing supply side risks through economic and policy-oriented actions. Therefore, there is need for the Government to monitor the cost of inputs, leakages in PDS, import and export policies, supply chain management etc. to address the economy during high food inflation and must see that the producers receive remunerative prices at the time of deflation. But, food inflation in India has sustained in recent past because of better production technology, bumper harvest, regular check on hoardings, export ban based on domestic price and demand.

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Plant Growth Promoting Rhizobacteria (PGPR)

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Eramma[1], Sangeeta Sabanna Bhajantri[1]
[1]Ph.D Scholar, Department of Agricultural Microbiology, University of Agricultural Sciences, Raichur.
[2]Ph.D Scholar, Department of Pathology, University of Agricultural Sciences, GKVK, Bangalore.

Introduction

Mycorrhiza is the mutualistic association between fungi of soil-borne and roots of higher plants (Sieverding, 1991). As all mutualistic beneficial co-operations, both partners (fungi and plant) have advantages of the symbiosis. Mycorrhizal fungi form symbiotic relationships with plant roots in a fashion similar to that of root nodule bacteria. In 1885 Albert Bernard Frank (Frank, 1885), in his study of soil microbial-plant relationships, introduced the Greek term 'mycorrhiza', which literally means 'fungus roots'.

Members of more than 80% of vascular plant families are capable of forming the AM symbiosis. Many researchers have studied the application of *Glomus mosseae*, *Glomus intraradices*, *Glomus clarum*, *Gigaspora gigantea*, and *Gigaspora margarita* on various crops. It was found that they have an important role in the enhancement of plant growth, nutrition, water relations and resistance without any recorded side effects. Different AM fungal species have been studied and found to be effective in reducing plant diseases caused by pathogens such as species of *Cylindrocladium*, *Fusarium*, *Macrophomina*, *Phytophthora*, *Pythium*, *Rhizoctonia*, *Sclerotinium*, and *Verticillium* on different host species.

Occurance

These AM fungal taxa form symbiotic associations with 80% of plant species. It is estimated that there are 20,000 EM fungal species, mainly belonging to Basidiomycota, followed by Ascomycota and Zygomycota, which form symbiotic associations with 2% of plant species, such as Pinaceae, Fagaceae. Betulaceae, Salicaceae and Dipterocarpaceae. The other mycorrhizal types occupy 10% of plant species. There is 8% of plant species belonging to nonmycorrhizal plants, such Brassicaceae, Crassulaceae, Haemodoraceae, Orobanchaceae, Proteaceae, and Restionaceae.

Types of Mycorrhizae

Of the seven types of mycorrhizae described (arbuscular, ecto, ectendo-, arbutoid, monotropoid, ericoid and orchidaceous mycorrhizae), arbuscular mycorrhizae and ectomycorrhizae are the most abundant and widespread.

Endomycorrizae: It is the most common widespread mycorrhizal association and form mutualistic relationships with over 80% of all vascular plants.

Ectomycorrhizae: Ectomycorrhizal (ECM) fungi are also widespread in their distribution but associate with only 3% of vascular plant families).

Ectendomycorrhizae: They possess characteristics of both ECM and AMthese fungi also occurs, a characteristic unlike that of ECM but consistent with AM.

Orchid mycorrhizae: This type have only been found in association with Basidiomycete species.

Ericoid mycorrhizae: They are known to form association between autotrophs in the Ericaceae and fungi in the Ascomycota.

Arbutroid mycorrhizae: They forms intracellular coils in outer cortical cells along with mantle and hartig net.

Monotropoid mycorrhizae: This type of association is formed by the achlorophyllus plants and they depending on the fungi for carbon and energy.

Special Structure

Arbuscules: Arbuscules are the places where the plant and fungus exchange food and nutrients with each other. Carbon and phosphorus and other nutrients may also be exchanged through hyphae that ramify inside the root, but it is likely that the arbuscules are the major site for nutrient exchange (Smith *et al.*, 2010).

Vesicles: Vesicles are swollen end cells either between root cells or within cell wall.Vesicles look like an oval bag and act as storage locations (Mosse, 1973) for fungal food reserves. Only three of the six genera of AM fungi (*Glomus*, *Acaulospora* and *Entrophospora*) form vesicles.

Functions of AM Fungi

Biological control using AM fungi has special significance being an eco-friendly and cost-effective strategy for disease management Mainly it acts as Phosphorus mobilize and stimulate N_2fixation in nodulated plants. Improve water absorption and drought and salinity tolerance of the plant. Improve the plant growth by improving P, Zn, N, Cu, Fe. It reduces the disease incidence by improving the plant nutrition. Mycorrhizal fungi relationship regulates the defense mechanism of plants. Colonization of plants with AM fungi significantly increased the growth parameters, yield parameters and mineral nutrient concentration. AMF colonization with plants reduced the disease severity and disease incidence by accumulation of some antimicrobial substance. Biological control using AM fungi has special significance being an eco-friendly and cost-effective strategy for disease management.

Mechanism of VAM

Changes in root morphology: AM fungal-colonized roots are more highly branched, i.e., the root system contains shorter, more branched, adventitious roots of larger diameters and lower specific root length. The AM inoculated plants possess a strong vascular system, which imparts greater mechanical strength to diminish the effects of pathogens (Gamalero *et al.*, 2010).

Physiological and biochemical changes: Generally, severity of the diseases get reduced by physiological and biochemical changes caused by mycorrhizal fungi in the host plant. Production of phytoalexin was greater on mycorrrhizal roots than on non-mycorrhizal roots and phytoalexins are believed to play a major role in the host defense system against pathogen.

Nutritional changes in Host: Mycorrhizal-induced decreases in root exudation have been correlated with reduction of soil-borne disease, while improved nutritional status of the host brought about by AM fungus-root colonization may affect quantitative changes in root exudates. Cotton field plants infected with a semi-endoparasitic nematode *Rotylenchulus reniformis* have the potential to tolerate higher PPN (Plant-parasitic nematodes) population densities in their roots (Pettigrew *et al.,* 2005).

Competition for colonization sites and photosynthates: AM fungi and soil-borne plant pathogens occupy similar root tissues and there may be direct competition for space if colonization is occurring at the same time (Smith, 1988). Localized competition between AM fungi and *Phytophthora* reduced development of *Phytophthora* in AM-colonized and adjacent uncolonized root systems and pathogens never penetrated arbuscule-containing cells. The number of infection sites was reduced within mycorrhizal root systems and colonization by the AM fungus had no effect on the spread of necrosis. Nutrient competition, especially on carbon competition, has been proposed as a main mechanism of the AMF-mediated biocontrol (Jung *et al.*, 2012).

Activation of defense mechanism: The activation of specific plant defense mechanisms as a response to AM colonization is an obvious basis for the protective behavior of AM fungi. The early stages of the interaction between AM and plant, the plant host responses to the interaction by activating defense-related responses and that are subsequently suppressed (Garcia-Garrido, 2002; Liu *et al.*, 2003). In mycorrhizal roots, growth of the pathogen was usually restricted to the epidermis and cortical tissues, whereas in non-mycorrhizal roots the pathogen developed further, infecting even the vascular stele. Fusarium hyphae within mycorrhizal roots exhibited a high level of structural disorganization, characterized by the massive accumulation of phenolic-like compounds and the production of chitinases. This reaction was not induced by non-mycorrhizal roots, suggesting that the activation of plant defence responses by mycorrhiza formation provides a certain protection against the pathogen. AM infection makes the root more responsive to pathogen attack*, i.e.,* promoting a quicker and stronger reaction against the pathogen.

Conclusion

AM symbiosis can also cause qualitative and quantitative changes in rhizospheric microbial populations; the resulting microbial equilibria could influence the growth and health of plants. These changes may result from AM fungus-induced changes in root exudation patterns. Changes in microbial populations induced by AM formation may lead to stimulation of the microbiota which may be antagonistic to root pathogens. There are various proposed mechanisms for the bio protection action of VAM fungi in sustainable agriculture system. The importance of VAM in increasing food production is far and wide; therefore, these can be used in modern sustainable agriculture particularly as biocontrol agent.

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Paddy Borer Complex and their Integrated Management

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Sourav Maji[1], Yogesh Kumar Patel[1], Dr. Dinesh Rai[2]
[1]Research scholar (Department of Entomology), Department of Entomology, Post Graduate College of Agriculture.
[2]Assistant professor (Department of Plant Pathology), Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur (848125-Bihar).

Abstract

Rice is the staple food crop for more than 60% of the world's population and most of the people of S.E Asia though its cultivation is done in only 11% of the world's cultivable land. About 90% of rice grown in the world is produced and consumed in Asia.

Area and Distribution:

Production- China>India>Indonesia; Productivity- USA>Japan>China
In India- Production- WB>UP>Bihar; Productivity- Punjab(34q/ha).

Several pests attack rice in different ways at different stages. There mainly six types of stem borer attack rice. These are the yellow stem borer, dark headed striped borer, white stem borer, striped stem borer, gold fringed stem borer & pink borer. Among the stem borers, the pink borer is less important. It is polyphagous and prefers sugarcane to rice. Increased reliance on pesticides for pest control is found to be unsustainable and cost-ineffective.

So, Integrated Pest Management (IPM) has been introduced as the best alternative for pest management in rice. IPM in rice helps to minimize risks to the environment and human health. Rice IPM uses the combination of cultural, use of resistant varieties, biological, physical, and chemical practices for pest control. To apply IPM against the pests we need to understand their bioecology & damage mechanism.

Rice Yellow Stem Borer, *Scirpophaga incertulas* (Wlk.) (Pyralidae: Lepidoptera)

Distribution: The yellow stem borer of rice attacks only rice (monophagous) and has wide distribution in all Asian countries. In India, it is distributed in all Asian countries. In India, it is distributed in all paddy growing areas: Assam, West Bengal, Orissa, Uttar Pradesh, Punjab, Andhra Pradesh and Tamil Nadu.

Biology: The female lays 50-70 eggs in a mass near the tip on the upper surface of the tender leaf blade & covers with buff-coloured hairs and scales. A female lay about 2-3 egg masses. Fully grown larva white or yellowish white in colour and bearing with a well-developed prothoracic shield. Larvae are reported to undergo hibernation from November to January and prior to diapause the larvae in stubbles move down into the plant base and remain 2-4 cm below the ground level.

Before pupation it covers the exit hole with thin webbing and then forms a white silken cocoon in which it pupates. The pupa is dark brown and measures about 12 mm long. The pupal period depends on weather conditions. The entire life cycle completed in 40-50 days. The female: male is 2:1 in the population. October-December has been found conducive for the multiplication of insect.

Egg mass —5-7 days→ Larva (5instars) —20-25 days→ Pupa —6-9 days→Adult.

Symptoms of damage:

a. At vegetative stage, the central leaf whorl does not unfold due to larval feeding and turns brownish and dries off, resulting in formation of '**dead heart**' & in flowering stage it produces '**white ear'** (chaffy ear heads) which can be easily pulled out.
b. Presence of entrance or exit holes on the stem.
c. Fecal matters are found inside the damaged stems. Frass at the feeding site is common when recent feeding has occurred.

Dark Headed Striped Borer *Chilo polychrysa* (Meyr.) (Crambidae: Lepidoptera)

Distribution: The insect was first noticed in Kerala in 1956 and since then has been reported to occur on rice in Tamil Nadu, Orissa, West Bengal and Assam.

Biology: The female lays from 20 to 150 flat broadly oval eggs in two or more longitudinal rows overlapping each other on the lower or upper surface of the leaf. The egg period is about 6 days. The full-grown larva is characterized by three dorsal and two lateral purplish brown stripes on the abdomen, a brownish black head and pro-thoracic shield.

It measures about 21 mm and the larval period ranges from 23 to 36 days. It pupates in a thin silken web inside the stem, the pupal period being about 4 days. The adult moth possesses brownish ochreous fore wings with 6-7 small black spots.

Damage symptom: The larva feeds on the central shoot by boring into it and as many as seven larvae can be noticed in a single shoot. The adjacent tillers are also damaged by the larvae, which migrate them, often resulting in the death of the whole plant.

White Stem Borer *Scirpophaga innotata* (Wlk.) (Crambidae: Lepidoptera)

Distribution: It is not prominent in India. It is mostly damaging and found in Southern Philippines and Java.

Biology: Female lays egg on masses mostly on leaf blades and covered the egg with tuft of anal hairs. Incubation period is about 5-8 days, larval period is about 20-30 days and pupal period is about 6-10 days. Adult moth is whitish in colour.

Damage symptom: Larvae tunnel into rice tillers and resulting in drying of shoot.

Asiatic Rice Borer or Striped Rice Stem Borer *Chilo suppressalis* (Wlk.) (Crambidae: Lepidoptera)

Distribution: It is widespread species, known from India, Srilanka, China.

Biology: Female lays scale like and translucent white to dark yellow eggs. The nacked clusters of eggs consist of nearly 60 overlapping rows. Early instar larvae are grayish white with a black head. Full grown larva yellow in colour and a length of about 25 mm. Pupation takes place in the stem.

Damage Symptom: Heavily attacked plants can show varying symptom from dead heart, white heads, dwarfing, stunting, rot and rosetting.

Gold Fringed Rice Stem Borer *Chilo auricilius* (Dudgeon) (Crambidae: Lepidoptera)

Distribution: It is found in India, Taiwan, Bhutan and Sri Lanka.

Biology: Adult has golden yellow fringed round on the forewing. Life cycle completed within 40-50 days.

Damage Symptom: Larvae bore into the stem and resulting into the drying of main shoot.

Pink Rice Stem Borer *Sesamia inferens* (Wlk.) (Noctuidae: Lepidoptera)

Distribution: It is found from Pakistan, India, Sri Lanka, Myanmar to Japan**.**

Biology: Female lays spherical, yellowish white eggs in batches of 30–100 eggs in two to three parallel lines on the leaf sheaths or the leaf surface. The larva is pinkish, smooth, and measures about 30 mm when full grown. The larva bores directly into the stem without leaf feeding during early instars. Pupation occurs in stem galleries and the life cycle is completed in 40–50 days. Moths have straw-colored forewings with a marginal dark brown streak. The pest completes four to five generations in a year under tropical conditions. It is a polyphagous pest.

Damage Symptom: Larva produce dead heart at vegetative stage and white ear at ear head stage.

Management Strategies

1. Cultural control:

a. Harvesting of crop close to the soil surface (removes larval & hibernating pupal stages).
b. Deep summer ploughing after the harvest.

c. Flooding the field.

d. Provide proper drainage in problematic areas so as to avoid water logging condition.

e. Grow tolerant varieties like Vikas, Ratna, Goutami, IR-20 and IR-26 in endemic areas.

f. Clipping the tops of leaf blades before transplanting.

g. Avoid aged seedling, if possible.

h. Removal of alternate host thatmean different weeds from crop fields and field bund.

2. Mechanical control:

a. Moths can be collected by setting light traps and killed.

b. Moths can be monitored by pheromone traps @4 traps/acre.

3. Biological control: Using the natural enemies like egg parasites- *Tetrastichus* sp., *Telenomus* sp., *Trichogramma* sp. @ 1 lakh/ha is released for an effective control of the pest.

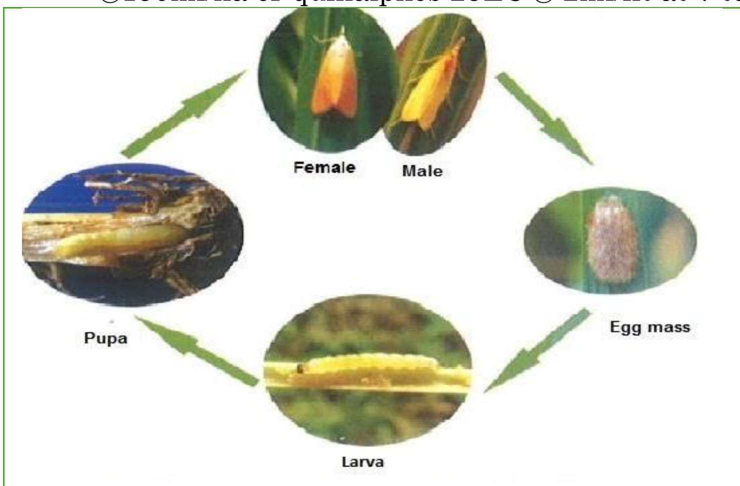
4. Chemical control:

a. Seedling root dip with chlorpyriphos @ 0.02% for 12-14 hours before transplantation.

b. Application of carbofuran 3G @ 1.5kg a.i/ha in nursery 5days before pulling, protects the crop in main field up to 30days.

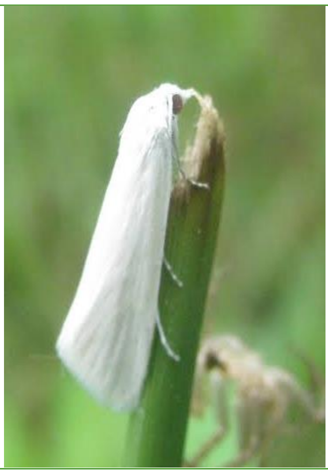
c. Application of chlorantraniliprole 0.4G @ 4kg/ha at 12 DAT (days after transplantation).

d. Spraying of flubendiamide 480SC (39.35% w/w) @50 ml/ha or chlorantraniliprole 18.5SC @150ml/ha or quinalphos 25EC @ 2ml/lit at 7 to 10 days interval.



Pic: Eggs, larva, pupa & adult of Rice YSB *(S. incertulas)*

Pic: Adult of *Chilo polychrysa*



Pic: Adult of *S. innotata*

Pic: Adult of *C. suppresalis*

Pic: Adult of *C. auricilius*

Pic: Adult of *S. inferens*

	
Pic: Dead heart symptom at vegetative stage	**Pic: White ear head symptom at ear head stage**

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Plant Growth Promoting Rhizobacteria (PGPR)

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Eramma[1]
[1]Department of Agricultural Microbiology, University of Agricultural Sciences, Raichur.

Introduction

Exploring nonconventional resources is an urgent need not only to mitigate the demand of ever-increasing population but also to sustain our ecosystem from the further degradation. Sustainability in the agriculture production cannot be attained without microbiological population in soil under the present circumstances (Vaxevanidou *et al*., 2015). Among these potential soil microorganisms, bacteria known as plant growth promoting rhizobacteria (PGPR) are the most promising. Plant growth promoting rhizobacteria are the soil bacteria that colonized plant root, rhizosphere and benefit the root rhizosphere growth. Facilitate the plant growth directly or indirectly. Decrease the global dependence on hazardous agricultural chemicals. Stimulate plant growth through mobilizing nutrients in soils. The term PGPR was proposed by Kloepper *et al.,* 1980 and has been used for a long time, especially for fluorescent Pseudomonas involved in the pathogens biological control and enhancing plant growth.

Characteristic of PGPR

1. Proficient to colonize the root surface.
2. Survive, multiply and compete with another micro biota.
3. Promote plant growth.

Types of PGPR

PGPR can be classified into two main types namely extracellular plant growth promoting rhizobacteria (ePGPR) and intracellular plant growth promoting rhizobacteria (iPGPR) (Viveros *et al.,* 2010). ePGPR inhabit the rhizosphere (on the rhizoplane) or in the spaces between the cells of the root cortex, whereas iPGPR mainly inhabit inside the specialized nodular structures of root cells. The bacterial genera included as ePGPR are *Agrobacterium, Arthrobacter, Azotobacter, Azospirillum, Bacillus, Burkholderia, Caulobacter, Chromobacterium, Erwinia, Flavobacterium, Micrococcous, Pseudomonas* and *Serratia*.

The endophytic microbes belonging to Intracellularplant growth promoting rhizobZcteria include *Allorhizobium, Bradyrhizobium, Mesorhizobium, Rhizobium* as well as Frankia species (Bhattacharyya and Jha, 2012).

Role of PGPR in Agriculture

Plant growth promoting rhizobacteria promote plant growth directly and indirectly. PGPR can affect plant growth by different direct and indirect mechanisms (Gupta *et al*., 2002). They stimulate plant growth through mobilizing nutrients in soils, producing numerous plant growth regulators, protecting plants from phytopathogens by controlling or inhibiting them, improving soil structure and bioremediating the polluted soils by sequestering toxic heavy metal species and degrading xenobiotic compounds like pesticides (Ahemad, 2012; Ahemad and Malik, 2011).

Nitrogen fixation: PGPR fix atmospheric nitrogen and provide it to plants by two mechanisms. Symbiotic nitrogen fixation: Mutual relationship between microbe and the plant. Non-symbiotic nitrogen fixation: Is carried out by free living diazotrophs. Biological nitrogen fixing PGPR help in disease management, growth promoting activity, maintain nitrogen level in agricultural soil (Damam *et al*., 2016).

Phosphorus solubilization: Phosphorus is the most important key element in the nutrition of plants. PGPR convert insoluble phosphorus (P) to an accessible form. PGPR act as inoculums to improve yield and growth. Phosphate solubilization mechanisms employed by PGPR: Release of complexing or mineral dissolving compounds. Liberation of extracellular enzymes. Release of phosphate during substrate degradation.

Potassium solubilization: Potassium is the third major essential macronutrient. PGPR solubilize potassium rock through production and secretion of organic acids. Potassium solubilizing PGPR are *Acidothiobacillus ferrooxidans, Bacillus edaphicus etc.*

Siderophore production: Siderophores is an iron-chelating compound help in assimilation of iron. Siderophores have been implicated for both direct and indirect enhancement of plant growth (Rathore, 2014).

Cytokinins and gibberlins production: PGPR *Azotobacter sp., Rhizobium sp., Bacillus subtilis* etc can produce cytokinins or gibberellins both or can produce either cytokinins or gibberellins for plant growth promotion. It appears that PGPR produce lower cytokinin levels compared to phytopathogens.

Indirect Mechanisms

PGPR is a promising sustainable and environmentally friendly approach to obtain sustainable fertility of the soil and plant growth indirectly.

Antibiosis: Antibiotics production is biocontrol mechanisms of PGPR against phytopathogens. Increased use antibiotic-PGPR as biocontrol agent develop resistance against antibiotic

Lytic enzymes: PGPR strains produce enzymes such as chitinases, dehydrogenase, ß-glucanase, lipases, etc. which exhibit hyperparasitic activity. They protect from biotic and abiotic stresses. Production of exo-polysaccharides is important in biofilm formation and root colonization. Effective colonization of plant roots by EPS-producing microbes helps to hold the free phosphorous and circulating essential nutrient to the plant. Functions performed by EPS producing microbes constitute shielding from desiccation, attachment invasion, and plant defense response interactions.

Impact of PGPR on Root System Architecture and Root Structure

Most terrestrial plants develop their root system to explore soil and find nutrients to sustain growth. In Fabaceae for example, the root tip help in initiating the rhizobial colonization process. In Poaceae, root hairs and lateral roots are colonized by PGPR. RSA integrates root system topology, the spatial distribution of primary and lateral roots, and the number and length of various types of roots.

PGPR as a biofertilizer: The search for PGPR and investigation of their modes of action are increasing at a rapid pace as efforts are made to exploit them commercially as biofertilizers. PGPR help in fixing N_2, increasing the availability of nutrients, positively influencing root growth and morphology, and promoting other beneficial plant–microbe symbioses. The combination of these modes of actions in PGPR is also addressed, and widespread utilization of PGPR as biofertilizers.

PGPR as a biocontrol: Bio control is a process through which a living organism limits the growth. The mechanisms of bio control by rhizobia include, competition for nutrients, production of antibiotics, production of enzymes. Rhizobial strains compete for nutrients by displacing the pathogens. Rhizobia starve the pathogens of available iron by producing high affinity siderophores (Fernando *et al.*, 2005).

Abiotic Stress Tolerance by PGPR

Stress tolerant crops with minimized production costs and environmental hazards can be by the use of PGP microbes as stress relievers. Indigenous and native microbes were effective and competitive. This includes: extreme of temperature, salinity, soil acidity, heavy metal resistance *etc.*

Conclusion

PGPR are economically and environmentally beneficial for plant growth promotion. PGPR may have a direct or an indirect mode of action. PGPR are excellent model systems which can provide the biotechnologist with novel genetic constituents and bioactive chemicals having diverse uses in agriculture and environmental sustainability. PGPR may function as biofertilizer, bioinoculant, and other growth promoting activity. New concept needs to be constantly developed.

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Proceedings to Improve the Seed Set in Sunflower

Article ID: 35159

Nallagatla Vinod Kumar[1], Bathula Venkatesh[1], Sheri Vaishnav[1]
[1]Department of Agronomy, College of Agriculture, PJTSAU, Rajendranagar, Hyderabad, Telangana-500 030, India.

Seed setting and filling problem is one of the most important constraints in sunflower production and often considered to be a major reason for low productivity. Besides poor agronomic management, there are several genetic, physiological and environmental factors causing poor seed setting and filling in sunflower. The sporophytic type of self-incompatibility mechanism is one of the genetic reasons for poor seed setting in sunflower. One of the means to alleviate this problem is to identify the self-fertile lines and thus increase seed set and productivity. The physiological mechanisms that regulate seed setting and filling in sunflower are complex. Studies carried out on source-sink relationship and photoassimilate distribution pattern revealed that the photoassimilate supply in the capitulum largely depends on the phyllotaxy of source leaves and the position of sinks in developing inflorescences. A higher proportion of empty achenes (up to 60%), especially in the centre of capitulum result from source limitation. During seed filling, maximum import of photoassimilate appeared in intermediate whorls, while central whorls always exhibited the lowest import leading to poor seed filling. The studies carried out on correlation of the metric traits helped in identifying the characters associated with seed setting and filling. The number of filled seeds per head can be increased up to a certain limit by increasing stem girth and head diameter. Good agronomic practices play an important role in production and productivity of any crop.

Seed Setting Constraints

In sunflower more ill-filled grains are formed due to poor seed setting since this is highly a cross pollinated crop. The main reasons for poor seed setting are:

1. Use of impure and qualities seed.
2. Due to less population of honey bees impairs cross pollination.
3. Due to heavy rains at flowering stage and high humidity pollen grains are washed off.
4. Because of high temperatures prevailed at the time of pollination the pollen grains will be dried up.
5. Due to lack of sufficient soil moisture at seed setting.
6. Due to deficiency of phosphorus and micro nutrients.
7. Excess nitrogen application.
8. Due to insect, disease and bird damage.
9. In sunflower, seed setting starts from periphery to centre of flower, which normally completes in 10 days. As seed setting is progressing the non-availability of both macro and micro nutrients is required proportions is one of the reasons for poor seed setting.

Steps to be Taken Up for Proper Seed Setting

1. Decide optimum seeding period in such a way that the flowering should not coincide with extremes of temperature, heavy rainfall and fog.
2. Use only pure and quality seed of high yielding varieties or hybrids.
3. Follow only recommended fertilizer schedule.
4. Avoid excess use of nitrogen, see that there is no phosphorus deficiency. At the crop age of 30 days there should not be any deficiency of N. Rectify the deficiency of micro nutrients if observed.
5. If sunflower is grown as rainfed rabi crop in heavy soils grow nearby fields of safflower or safflower as intercrop so that the activity of honey bees can be increased.
6. Honey bees are attracted by yellow flowers and the honey dew available in flowers of niger. Hence grow niger around the field of sunflower so that fertilization can be improved.
7. Establish more plant population per unit area, otherwise large sized flowers are produced cause poor seed setting in the centre of the flower.
8. Grow the crop, if possible, east to west to avoid shading of one row on the other.

9. Keep 2-3 honey bee colonies to activate honey bee activity and to increase crop pollination. It also gives additional income from honey.
10. See that there should not be any moisture stress from bud formation to flowering and milking of seed stages.
11. From flowering on wards necessary plant protection measures are to be taken and also bird scaring.
12. During flowering period spray insecticides mostly during evening periods.
13. Spray cycocel 50 ppm at 40- and 60-days age of crop to increase yield through better seed setting.
14. Rub the flowers of opposite lines at flowering period between 8-11AM and 3-5 pm to obtain more cross pollination.
15. Rub the flower with smooth cloth or cotton at flowering time between 8-11 am on every day or on alternate days for 10-15 days to increase cross pollination. This operation gives 25% higher yield. At the time of rubbing if tobacco caterpillar or gram caterpillar observed on flowers better pick then and destroy to reduce the crop damage.

Biochar as Soil Amendment for Remediation of Heavy Metal Contaminated Soil and Sustaining Crop Productivity

Article ID: 35160

M. Vassanda Coumar[1], J. K. Saha[1]
[1]ICAR-Indian Institute of Soil Science, Bhopal-462038, Madhya Pradesh, India.

Abstract
Anthropogenic sources of heavy metal contamination are evident due to intensive agricultural practices such as herbicide and pesticide application, waste water irrigation, municipal solid waste and even chemical fertilizer containing traces of heavy metals are the major sources of heavy metal contamination in soil. A serious attention is required to control heavy metals reaching to soil and also to remediate heavy metal contaminated soil. Recently, addition of biochar to soil have shown definite increases in cation exchange capacity, pH and other soil properties. It also improves the overall sorption capacity of soils and therefore it might influence the toxicity, transport and fate of different heavy metal in the soil.

Keywords: Biochar, soil health, heavy metal, crop yield.

Introduction
In the recent years, land degradation has emerged as a global issue due to increasing pressure on land resources caused by rapidly increasing population. Further, small scale industries located in urban areas often dispose of their wastes along with municipal solid wastes (MSW). The major environmental risk related with MSW is that during decomposition the heavy metals remains unaffected which have toxic effects on organisms at certain concentration which exceed threshold level. Applications of heavy metal contaminated compost as manure may result in heavy metal accumulation in plant and may pose risk to human health through food chain contamination. Excessive accumulation of heavy metals may cause blood and bone disorders, kidney damage, neurological damage, etc in human beings. Therefore, a serious attention is required to control heavy metals reaching to soil (source level) and also to remediate heavy metal contaminated soil (sink level).

Historically, remediation techniques have involved various degrees of excavating contaminated soil to landfill, a practice now generally considered environmentally disruptive and economically unfeasible (Salt et al., 1995). A modern technique of inorganic contaminants stabilization particularly heavy metals by processes of adsorption, binding or co-precipitation with the additive amendments (Kumpiene et al., 2008) has been widely researched in the last decade (Clemente and Bernal, 2006). Among the various amendments utilized for *in- situ* contaminants stabilization, materials rich in organic component such as manures, biosolids and organic composts, have proved successful at reducing the mobility of contaminants in multi-metal polluted soils (Clemente and Bernal, 2006). Furthermore, increasing interest in integrating remediation and the provision of ecosystem services, such as carbon sequestration in soils, has provided an attractive land management option for contaminated sites using materials rich in carbon.

Biochar as Soil Amendments
Biochar has gained significant importance in recent days as a soil amendment because of its potential benefits for carbon sequestration in soil (Lehmann, 2007). Biochar is referred to product obtained from a incomplete burning of biomass rich in carbon. Due to the high stability of carbon in biochar (recalcitrant pools), its addition to soil may act as a carbon sink. An example of the stability of biochar is the Terra Preta soils found in South America. These soils are still very fertile and suitable for agriculture. Terra Preta soils to be more fertile than the Ferralsols in the area. The Terra Preta soil had higher concentrations of C, N, P, Ca and also higher cation exchange capacity (CEC), base saturation (BS) and pH, indicating higher fertility and productivity. Recent studies have also highlighted that biochar are effective soil amendments to improve the agronomic values of soil. Moreover, biochar is known to have a highly porous structure,

contain various functional groups which tends to have strong sorption affinity for organic compounds and also play an important role in controlling organic pollutants in the environment. The formation of surface functional groups and adsorption sites on biochar could influence its CEC (Liang et al., 2006) and consequently the capacity of biochar amended soils to form complexes with metal ions.

Biochar on Crop Yield and Soil Health

Biochar holds as a promising tool for sequestering carbon (C) in soil and other potential benefits. Biochar application in agricultural soils also results in changes in pH, electrical conductivity (EC), cation exchange capacity (CEC) and nutrient levels. The alkaline materials in biochar assist liming in soils and may raise neutral or acidic soil pH. The soil pH, electrical conductivity (EC), soil organic carbon, available nitrogen and phosphorous, cation exchange capacity and exchangeable bases were substantially increased following the application of biochar. The highest mean values of pH and EC were observed in soils treated with highest level of biochar, while the lowest values were recorded at the control (unamended soil). Coumar et al. (2016) concluded that soil organic carbon content in the postharvest soil amended with biochar at 2.5 and 5 g kg^{-1} soil increased to an extent of 34.9 and 60.5 %, respectively.

Research has also proved that crop yields can be improved by biochar application. Depending on the amount of biochar added, significant improvements in plant productivity were achieved which ranges from 20% to 220%. Coumar et al. (2016) reported that application of biochar (at 2.5 and 5 g kg^{-1} soil) significantly increased the dry matter yield of spinach leaf by 5.07 and 15.02 %, respectively, and root by 14.0 and 24.0 %, respectively over the control. Biochar application also resulted in higher grain yields at sites with low P availability and improved the response to N and NP chemical fertilizer treatments. Also, biochar application has reported reduced leaf chlorophyll concentration which may be possibly through a reduction in soil nitrogen availability, indicating that biochar application without additional N fertilizer application could reduce grain yields in soils with a low indigenous N supply.

Biochar on Heavy Metal Mobility in Soil and Plant Uptake

Recent studies from the literature showed that additions of biochar to soil have shown definite increases in cation exchange capacity (CEC), pH and other soil properties. Biochar application also improves the overall sorption capacity of soils and therefore it might influence the toxicity, transport and fate of different heavy metal in the soil. Biochar application decreased the concentration of both As and Cd in maize shoots can be attributed to the formation of stable metal-organic complexes (Namgay et al.,2010). The results showed that application of biochar significantly reduced extractable Cd, Cu and Pb concentrations of soils, indicating the immobilization of these metals (Park *et al.* 2011). Uchimiya et al. (2012) also reported that long-term effectiveness of biochar for heavy metal stabilization depends upon biochar's sorptive property and recalcitrance in soil. The biochar was six times more effective in Pb sorption than activated carbon. Soil respiration and microbial population growth rate are also significantly altered by charcoal/biochar amendments. Coumar et al. (2017) reported that application of FYM and charcoal/biochar, either in combination or alone, proved to be effective than lime with respect to microbial functional resistance and resilience of acid soil under Cu stress. Also, pigeon pea biochar application resulted in reduction in the bioavailable content- DTPA extractable cadmium in the soil and its subsequent transfer from soil to plant, as well as spinach leaf and root Cd concentrations, indicating that cadmium mobility was decreased (Coumar et al., 2016).

Conclusion

Biochar holds as a promising tool for sequestering carbon in soil and other potential benefits. Biochar applications in soil have shown definite increases in cation exchange capacity, pH and other soil properties related to soil chemical, physical and biological parameters. It also improves the overall sorption capacity of soils and therefore it might influence the toxicity, transport and fate of different heavy metal in the soil.

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Technology Transitions in Indian Agriculture

Article ID: 35161

Navitha Raj[1]
[1]PhD Scholar, Department of Agricultural Extension, College of Agriculture, Vellayani.

Introduction

Agriculture serves as the backbone or one of the important pillars of Indian Economy. It not only feeds the entire population but also provides employment opportunities to millions of people in India. The World Economic Forum estimates 55% of the population employed in agriculture and its allied industries contributes to 17% of the Gross Domestic Product (GDP) of the country (Passah, 2019).

Whereas the main source of national income comes from the services industries which generates 55.65% of the GDP of India. Despite India being an agrarian economy, farmers face a number of challenges such as increasingly erratic climatic conditions, resource degradation, limited access to resources, poor market facilities and policy paralysis which altogether affects agriculture sector.

Maintaining agricultural productivity and sustaining farmers livelihoods are important challenges in India. It becomes necessary to explore ways in which yields can be increased by more efficient input technologies.

With increasing population, urbanisation and contagious depletion of natural resources, the transformation of agricultural sector is huge. There is a paradigm shift in farmer's perception from production to productivity and to profitability. Therefore, agriculture sector is ever evolving with advent of new and modern technologies creating a technology transition (Dev, 2018).

Technology

It is the application of scientific knowledge for practical purposes (Franklin, 1989). For a given problem set, a technological transition is therefore a shift from one dominant paradigm to another. Ogburn (1947) states four stages of technological development: invention, accumulation, diffusion and adjustment.

Three Phases of Agricultural Transitions in India

Agricultural sector in India has moved from a traditional agriculture in the 1950s to the modern technologically dynamic high capital-intensive agriculture.

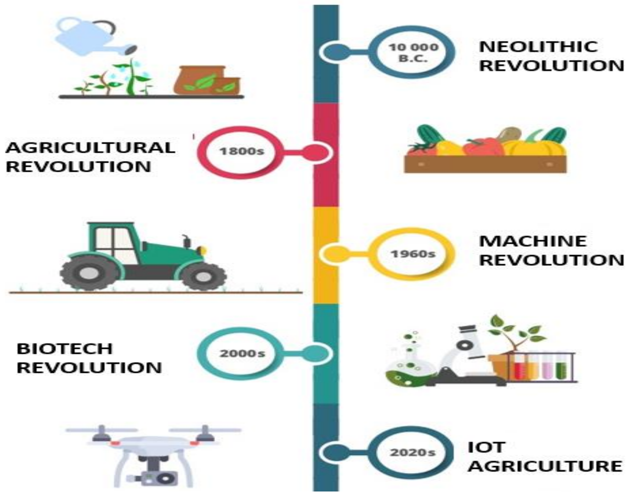
1. Traditional agriculture: This is a technologically stagnant phase in which a larger farm production becomes possible only through increased application of all three inputs i.e., land, labour and capital. Till mid-1960s, the Indian agriculture was typically embodied within the framework of traditional agriculture.During 1960-61 to 1966-67, production either declined or remained stagnant in the case of a number of major crops, especially food grains. This led to a serious crisis in the Indian economy prompting a re-appraisal of the growth strategy which brought about a transformation in Indian agriculture, leading to phase II of Indian agriculture.

2. Technologically dynamic agriculture with low capital investment: This is the beginning of the process of transformation from traditional agriculture to modernization. The distinguishing feature of phase II is the application of science and technology, evolved by research institutions. This phase of agriculture transformation came to be known as the period of Green Revolution**.**

3. Technologically dynamic agriculture with high capital investment: Indian agriculture entered the third phase towards the end of the 1980s. During this period, the non-agricultural sectors also entered modernisation. This phase is characterised by the substitution of labour by capital by way of large-scale farm machinery (Mondal, 2015).

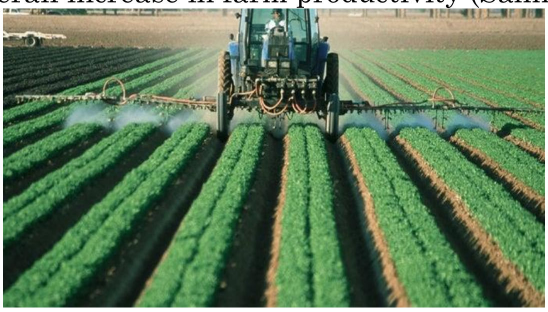
Transitions in Agriculture

1. Neolithic Revolution- referred to as the first agricultural revolution, marked the transition from hunter gather lifestyle to sedentary farming with plants and animals.



2. Agricultural revolutions- new patterns of crop production and livestock utilization paved way for better crop yields.

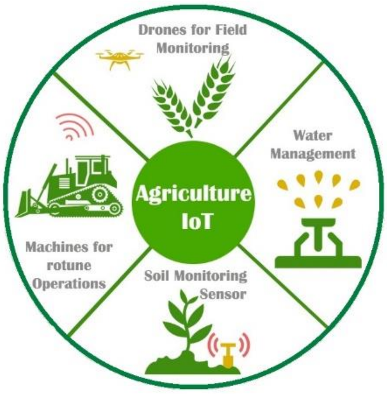
3. Machine revolution- farm mechanization and use of modern equipment for timely and effective completion of different operation in the agricultural field maximize profitability. Farm mechanization can help in 15-20% savings in seeds, 15-20% savings in fertilizers, 20-30% savings in time, 20- 30% reduction in manual labour and 10-15% overall increase in farm productivity (Sahni, 2018).



4. Biotech revolution- advanced technologies such as genetic engineering and genetically modified organisms used in agriculture maximized the output.

5. IOT (Internet of Things) revolution - IoT is a network of interconnected devices which can transfer data efficiently without human involvement (Udhaya *et al*., 2018). Smart farming system is a farming system where IoT helps in monitoring the crop with the help of modern sensors and automated production, protected systems and e-value chain management (FAO, 2017).

Livestock monitoring: IoT applications help farmers to collect data regarding the location, well-being, and health of their cattle. This information helps them in identifying the condition of their livestock.



Conclusion

The advantage that technology has provided in the agricultural sector are numerous. There are many innovative water-efficient technologies, drought-tolerant seeds, crop protection products, and optimised irrigation systems that can tackle the vagaries of weather. There are technologies that use moisture more efficiently to give higher yields on drought-stressed land. The genetically modified technology introduced in crops helps fight various stresses that affect growth. The advancement in technology has introduced a new economy, sociability and consciousness among the people. It is considered to bring systems and infrastructure to strengthen the country's workforce, establishing a firm foundation towards sustainable practices and eventually progress leading to social change.

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Panchagavya: Microbiology and Its Role in Plant Growth Improvement

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Anandakumar Selvaraj[1], Umapathi Muniyappan[2], Rakavi Balu[2]
[1]Department of Agricultural Microbiology, Tamil Nadu Agricultural University, Coimbatore – 641 003.
[2]Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore – 641 003.

Introduction

Panchagavya (PG) is a traditional fermented organic product extensively utilized to grow various agricultural and horticultural crops, which is prepared by mixing of five byproducts from cow such as dung, urine, milk, curd, ghee and other ingredients. This preparation contains beneficial microorganisms beside to macro and micro-nutrients, amino acids, and growth-promoting substances.

Panchagavya associated beneficial microorganisms known to promote plant growth *via* solubilizing phosphate, zinc oxide and production of siderophores and plant growth promoting substances as well as increasing plant resistance to various environmental stresses. The beneficial effects of biodynamic preparation, *panchagavya* on various crops have been reported to increase the yield of cereal and vegetable crops significantly.

Besides to improving plant growth, *panchagavya* also improves plant tolerance to pests, pathogens, salinity and drought by developing resistance and increasing soil fertility, nutrients, plant growth and metabolic alteration. It can be applied as a foliar spray or mixed in the soil during irrigation and can be utilized by seed treatment (Tharmaraj *et al*., 2011).

Panchagavya Associated Microbes and their Importance in Crop Growth

Panchagavya contains versatile of effective beneficial microorganisms (EMO), like *Azospirillum*, *Azotobacter*, *Pseudomonas*, *Lactobacillus*, *Saccharomyces*, *Streptomyces*, *Rhodopsuedomonas*, *Aspergillus,* ammonifiers, nitrifiers and phosphobacteria, along with plant growth stimulating substances and nutrients.

These plant growths promoting microbes colonize in the rhizosphere, to improve crop growth and development by increasing the uptake of nitrogen, production of siderophores, as well as solubilize phosphates and zinc oxide, *etc*. Moreover, microbes play a crucial role in plant growth by adding growth promoting substances, such as indole acetic acid. The presence of beneficial microorganisms in *panchagavya* plays a major role as a growth enhancer and makes the soil more productive. Although the application of *panchagavya* increased the total beneficial microbial population in the rhizosphere, which improved the growth of the plants by enhancing the availability of nutrients like nitrogen, phosphorus, potassium, zinc, copper *etc*., and plant growth hormones as well.

Moreover, *Panchagavya* application not only enhances the microbes in the environment but also acts as a catalyst with a synergistic effect to promote all the useful microbes of the environment and these microorganisms secrete proteins, organic acids and antioxidants in the presence of organic matter and converted them into energy thereby the soil microflora and fauna changed a disease-inducing soil to a disease suppressive soil (Amalraj *et al*., 2013).

Plant Growth Promoting Mechanisms of *Panchagavya*

The organic preparation *panchagavya* has a versatile role in plant growth and soil fertility improvement by imparting different mechanisms *viz*., supplying nutrients, amino acids, vitamins, plant growth-promoting substances and beneficial microorganisms. Besides improving plant growth, it also enhances plant defense to various biotic and abiotic environmental stresses. Along with improving plant growth and health, *panchagavya* also improves soil fertility and health by enhancing soil microbial activity, organic matter decomposition, soil-borne disease suppression and soil available nutrients (Kumar *et al*., 2020).

Panchagavya on Plant Nutrients

Management of nutrients is one of the important factors, which directly influence plant growth by changing the capacity available nutrients. *Panchagavya* contains several nutrients including macronutrients (nitrogen, phosphorus and potassium) and micronutrients (calcium, magnesium, zinc, sulphur and iron), which are required for the growth and development of plants. *Panchagavya* inoculation improved seed germination percentage and seedling vigour index, root length, shoot length and biomass accumulation. It can be speculated that *panchagavya* ingredients could have served as a source of nutrients to either plant or microbial flora, which might have enhanced and ultimately improved the root and shoot development (Tharmaraj *et al*., 2011).

Plant Growth Hormones, Amino Acids and Vitamins of *Panchagavya*

Panchagavya also contains various amino acids, vitamins, growth regulators like indole acetic acid (IAA) and gibberellic acid (GA). Foliar spray of *panchagavya* enhances photosynthetic pigments and protein in different plants as a result of growth hormones and secondary metabolites present in *panchagavya*. Besides that, the presence of beneficial microorganisms in the *panchagavya* increases the synthesis of phytohormones, which in turn could have stimulated the growth and biomass of plants (Tharmaraj *et al*., 2011).

Effect of *Panchagavya* of Soil Fertility Improvement

1. *Panchagavya* improves fertility status of the soil by increasing available nutrients.
2. Micronutrients and beneficial microorganisms thus increase soil health.
3. It improves water holding capacity of the soil because it acts as an organic manure.
4. It encourages growth and reproduction of beneficial soil microorganisms.
5. It increases uptake of nutrients in plants and enhances plant growth.

Panchagavya (PG) Preparation

Panchagavya is prepared by mixing five different byproducts of cow mainly cow dung, cow urine, milk, curd and butter. Besides, the ingredients like tender coconut, sugarcane and other materials are also used for *panchagavya* preparation concerning the local practice. Briefly, fresh cow dung is first mixed with ghee thoroughly and kept in shade for three days. This mixture is stirred for 15 minutes daily both in the morning and evening. After the 4th day of the incubation period, the ingredients like cow urine, cow milk, cow curd, sugarcane juice and yeast powder are added to this mixture and mixed thoroughly. This mixture is left for 15 days with stirring twice a day for at least 15 minutes. On 19th day of incubation, *panchagavya* solution is filtered and used for crop application (Rao *et al*., 2015**)**.

Panchagavya (PG): Method of Application and Recommended Dosage

Panchagavya is used in different ways such as foliar spray, fertigation and seed or seedling treatment. Many scientific reports suggest that 3% *panchagavya* solution is used as a foliar spray on many agricultural and vegetable crops like rice, blackgram, maize, okra, hot pepper and tomato, onion, snake gourd, green amaranth, eggplant, potato and so on (Murugalatha *et al*., 2019).

Beneficial Effects of *Panchagavya*

Panchagavya plays a crucial role in every component of crop management like integrated management of soil fertility, insect-pests, and diseases. The beneficial microorganisms of *panchagavya* and their establishment in the soil have improved the sustainability of agriculture as the microorganisms present in the rhizospheric environment, *i.e*., around the roots, influence the plant growth and crop yield. This might be due to the presence of growth accelerating enzymes in *panchagavya*, which favour rapid cell division and multiplication. *Panchagavya* is used as fertilizers and pesticides in agricultural operations and to prolong the shelf-life of fruits and vegetables.

1. To maintain the genetic biodiversity of the crops and the environment.
2. To encourage the biological cycles within the farming system by using microbes.
3. To promote the sustainable use of a natural resource.
4. To maintain the ecological balance between crop production and livestock.
5. To assess the efficiency of *panchagavya* in crops.

6. To produce a high-quality crop yield in enough quantity by using *panchagavya*.

Conclusion

In the modern scenario, excessive use of inorganic fertilizers and pesticides to increase agricultural production leads to a negative impact on the environment and human health. The adverse effect of these chemicals can be reduced or eliminated only through adopting new agricultural practices. In this context, there is an urgent need to develop an eco-friendly and sustainable technique to improve crop productivity and soil fertility. The use organic-based plant growth stimulator, *Panchagavya* is a best alternative to maintain sustainable agricultural production without affecting the natural ecosystem. It has the potential to improve plant growth by supplying nutrients, amino acids, vitamins, growth regulators, and beneficial microorganisms. Besides improving plant growth, it also augments the plant defense to various environmental stress. With this immense mechanism, *panchagavya* could be a better organic plant growth promoter for sustainable agricultural production.

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Genetic Improvement of Natural Enemies of Insect Pests

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Srishti Choudhury[1], Abhibandana Das[1]
[1]M.Sc. Student, Department of Entomology, Post Graduate College of Agriculture, Dr. Rajendra Prasad Central Agriculture University, Pusa (Bihar) 848125.

Introduction

India loses about 30 % of its crops due to various insect pests and diseases each year resulting in estimated annual revenue losses of Rs. 100,000 crores. As major agricultural inputs and vital part of modern crop-management practices, synthetic pesticides have fundamentally added to the improved agricultural production by reducing yield losses. But the non-judicious and unscientific use of different synthetic pesticides has led to many ecological and environmental backlashes. These concerns have renewed people's interest in environment-friendly approaches to pest management as well as biological control of insect pests. The limited success of biological control is mainly due to narrow spectrum of activity of bio control agents, their susceptibility to pesticides and adverse environmental stress, and slow speed of kill. Hence genetic improvement of natural enemies can be considered as an effective tool in improving their performance.

Genetic Improvement of Arthropod Natural Enemies

Genetic improvement involves directed purposeful genetic alterations to enhance the efficacy of biocontrol agents for biological control. It may be achieved by artificial selection, hybridisation to achieve heterosis effects or use of recombinant DNA techniques. Biotechnological interventions can offer opportunity to improve beneficial arthropods for the following (Routray *et al*., 2016):

1. Improved climatic tolerances: The temperature preference of parasitoid *Dahlbominus fuscipennis* strains was modified for oviposition, fertility, increased fecundity, and reduced variability in development, oviposition and adult life span.

2. Improved host finding ability: Example: *Trichogramma minutum*

3. Changes in host preference: Example- *Diadegma molestee*

4. Improved synchronization with the host: Example- *Cotesia melanoscela*

5. Insecticide resistance: Resistance was developed in Phytoseiid mite *Metaseiulus occidentalis* to organophosphorous and sulfur insecticides and later to carbaryl- OP and permethrin-OP

6. Non-diapause: Example- *Apanteles melanoscelus, Aphidoletes aphidimyza, Metaseiulus occidentalis*

7. Induction of thelytokous reproduction: Example- *Matrus carpocapsae, Dahlbominus fuscipennis, Muscidifurax raptor.*

Emerging Technologies in Augmentation of Natural Enemies

Three potential genetic manipulation tactics are being utilised in crop breeding for achieving the above goals viz artificial selection, hybridization or, use of heterosis and use of biotechnology (recombinant DNA (rDNA) techniques).

1. Artificial selection: Artificial selection of arthropod natural enemies for resistance to pesticides has been proposed as a method for improving the usefulness of natural enemies in integrated pest management programs (Roush and Hoy, 1981; Hoy, 1985).

Developing multiple-pesticide tolerant strain of *Trichogramma:* A strain of *T. chilonis* (MITS-TC) tolerant to multiple insecticides viz monocrotophos, endosulfan and fenvalarate was developed and it was evaluated against *Helicoverpa armigera* in field. The exposure to tebufenozide, spinosad and indoxacarb increased the tolerance levels of MITS-TC by 137.0, 372.5 and 761.4 % over susceptible populations for 34 generations during the year. Lamda cyhalothrin tolerance was completely dominant whereas spinosad tolerance appeared to be semi dominant and endosulfan tolerance was found to be recessive for crosses with the tolerant male and female parents.

Monocrotophos resistant green lace wing, *Chrysoperla carnea*: Patel and Yadav (1995) have reported the monocrotophos resistant strain of *C. carnea.* The same strain has showed cross-resistance to other insecticides viz., Dimethoate, Acephate, Phosphamidon and Methyl-o-demeton (Patel and Yadav, 2000).

2. Hybridization:

Development of Hybrid Trichogammatid*:* Hybrid *T. chilonis* strain was developed to express tolerance to both high temperature and repetitive pesticide sprays. Due to the ability to survive and parasitise *C. cephalonica* eggs temperature tolerance to 32-38°C was induced in the multiple insecticides-tolerant strain of *T. chilonis*. Both strains were kept together and allowed to mate with each other for 24 hours before being exposed to insecticides, fenvalerate (0.4 ml/l), monocrotophos (1.5 ml/l) and endosulfan (2.0 ml/ 1) and then to higher temperature. The percent parasitism after 5 days and survival of parasitoids after 6 and 24 hours was recorded. Further, tolerance to temperature 32^{o}C, 50% RH and newer insecticides (Avaunt, Tracer and Mimic) was induced in existing multiple insecticides-tolerant strain of *T. chilonis*.

3. Recombinant DNA (rDNA) techniques: Mutagenesis and recombinant DNA technology are the new techniques rising in genetic improvement of insects. In this technique desirable gene(s) are identified, cloned and inserted into natural enemies. Then the gene is incorporated into their genome, made stable and then expressed in the appropriate tissues and at the appropriate time transmitted to the progeny. The transformed natural enemy strain should be fit and able to perform well in agricultural systems.
Genetic transformations can be deployed in natural enemies to:

a. Modify the genome of natural enemies.
b. Change the sex ratio
c. Cryopreservation
d. Develop genetic linkage maps
e. Identify biotypes
f. Improve artificial diets
g. Monitor establishment and dispersal.
h. Parentage analysis and genetic changes.

Genetic Engineering in *Bacillus thuringiensis*

Need for the dissemination of large number of spores and repeated spray application arises from limitations of Bt such as poor persistence under field conditions. Two methods have been taken into consideration to address these factors concurrently and both of them requires engineering of a bacterium that is not generally pathogenic to pests. In the first case cloning of ICP genes is done to produce a nonpathogenic strain of *Pseudomonas fluorescence* and in the process the bacteria are killed, which results in encapsulation of ICPs. This has enhanced residual properties in the field but lacks Bt spores. In 1985 the EPA approved small-scale field trials of this product, which made it the first recombinant Bt product to be approved for outdoor testing. In the second case, a spoOA mutant strain of *B. subtilis* is used, where the gene spoOA is involved in sporulation initiation, and disruption of this gene prevents sporulation. This strain is engineered to express CryIIIA, which acts against Coleoptera. Both of these novel formulations provide stabilized and environmentally safe Bt-based biopesticides.

Genetic Engineering in Entomopathogenic Fungi

After application of fungal spores, dependence of the effectiveness of control on the relative humidity is one major limitation in the use of entomopathogenic fungi such as *Metarhizium anisopliae* and *Beauveria bassiana*.

Constraints in Genetic Improvement Project of Naturel Enemies

Developing a genetically modified natural enemy faces several constraints like:
1. The elements limiting the natural enemy's effectiveness must be recognised. A considerable deal about the behaviour, ecology and biology of the natural enemy must be known. Improper identification of the trait which requires to be improved may result in a costly and time-consuming project with little practical effect.
2. While using artificial selection, genetic variability must be available. Mutagenesis or recombinant DNA methods should be used, if this variability is not present in natural populations.
3. To prove effectiveness in the field, documentation of the improved natural enemy should be done.

4. The benefits achieved must justify the cost of the project.

Conclusion

When the natural enemy acts as a potentially effective biocontrol agent, genetic improvement can be useful. Biological attributes such as reducing developing rate, changing sex ratio, increasing progeny output, extending relative humidity tolerances as well as temperature and altering host or habitat preferences could enhance the natural enemy efficacy in the fields. A single major gene usually primarily influences the limiting trait in the natural enemy. This gene can be procured by selection, mutagenesis or cloning and the resultant strain is effective and fit. However, genetic improvement in natural enemies of arthropods has gained little attention due to concerns like breeding and extended rearing under artificial conditions might result in laboratory-adapted strains that would not function efficiently in the field.

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Mosquito Combating Techniques

Article ID: 35164

L. Allwin[1], G. Sathish[2]
[1]Assistant Professor, Regional Research Station, TNAU, Vridhachalam.

Introduction

About 400 different *Anopheles* species exist in the world, among that 30-40 species of *Anopheles* act as vector for four different species of parasites like *Plasmodium* that causes malaria which affects human being in the areas of endemic region, the dangerous one is *Plasmodium falciparum*. Culex mosquitoes mostly prefer warm blooded animals. Some species prefer cold blooded animal s also. They prefer shallow polluted a water body to lay eggs that are cigar-shaped without a float and laid in rafts on stagnant and dirty water. Mosquitoes lay their eggs either singly on the ground, or above the water, stagnant water bodies in tree holes and containers. Generally, breeds well in ditches and do not live-in running water streams or deep-water bodies of ponds and lakes. *Mansonia* is a culicine mosquito. *Mansonioides annulifera* is restricted to Kanyakumari district where it can transmit both *Wuchereria bancrofti* and *W. malayi* types of Filariasis.

Not only to humans but also to human being's mosquito transmits diseases. Mosquitoes giving nuisance and discomfort to the public and domestic animals. Survey and statistical data surveillance impart knowhow on pest and disease vectors of mosquitoes before creating a bigger issue in the environment. Assessing the risk of vector-borne diseases is the need of the hour and creating awareness among the public on principles and methods of management is a much needed one (James *et al.,* 2016). Insect Pest Management (IPM) is one of the crucial management practices that uses biological agent such as bio-pesticides, botanical pesticides and transgenic which is eco-friendly to control insect pests with minimum residues (Kumar Varun Vijay *et al*., 2021).

Physical Control

This method of controlling mosquitoes could completely eradicate the population of mosquito larvae in a ecofriendly manner. There are several methods to follow and few are presented below.

Environmental modification: The pH of the stagnant water bodies can be commuted and which ceases the breeding capacity of mosquitoes.

Water management: The following methods of managing water bodies could brought down the population in a drastic way.

Runneling

By forming spoon shaped channels in the areas of tidal inundation and networking the channels which makes runnels to pool the water from different locations of sources. It paves a way for the accessibility of predators and parasitoids in reducing the larval population of mosquitoes and also water flushing inturn kills the fragile wrigglers which are so active in water bodies.

Draining

Generally, mosquitoes prefer to breed in clean stagnant water bodies. During rainy season the chances for increasing the populations are more conducive. Thrown out bottles, tyres, containers, coconut shells and pouches giving rooms for the breeding of mosquitoes. More interestingly it is recorded that rice fields, open wells, small ponds, unclosed house water tanks, etc., also paving route for the breeding of mosquitoes. As a prophylactic measure it is possible to drain out and keep the premises clean and tidy.

Filling

Water stagnant areas may be covered with sand from nearby sources and filling those areas prevent mosquito breeding which helps to minimize the population of mosquitoes.

Chemical Control

Larvicides and adulticides are the least option to curtailing the population of mosquitoes in various means of application methods.

Larvicides are the one which kills the larval mosquitoes instantly and thus preventing to enter the adult stage. Altosid and temephos are the predominantly used larvicides worldwide to control the larva in effective manner.

(S) methoprene (e.g., Altosid). It is a selective larvicide which mimicks the action of Juvenile hormone (JH), an insect growth regulator hormone. Following application, the larva continues to grow and pupate, but adult fails to emerge from the pupal case. It is harmful to crustaceans, molluscs and other insects. Oragnophosphate insecticide (e.g. temephos 50 EC) may be used alternately with less toxic treatments such as Bti and methoprene.Others include malaria larvicidal oil (MLO), pyrethrum 0.2 % emulsifiable oil, Paris Green, fenthion 82.5 % EC, diflubenzuron 25 % EC.

Adulticides are the chemicals which kills the mosquitoes in adult stage. The anti-malarial control measures depend upon on the use of insecticides and the instant knockdown effect controls the population but polluting the environment by leaving residues.

Adulticiding is a common technique being followed worldwide though the efficiency is much lower due to dispersal of chemicals in the environment and killing of non-target organisms. But the widely followed method is adulticiding in order to reduce disease spread in human being.

Thermal fogging provides a rapid, temporary control for adult mosquitoes with no residual effect. Thermal fog generators break up the insecticide by means of hot gases or steam to produce smoke or fog. They are effective only when there is little or no wind in the evening or night. Malathion (5 litres / 95 litres of diesel) and deltamethtrin 1.25 % ULV (1 litre / 199 litres of diesel) can be used for outdoor thermal fogging.

Mist and residual sprays are applied with mist blowers, pump sprayers, power backpacks or hand sprayers. Residues from spray deposits remain active for several days to weeks depending on the environmental factors like rainfall, exposure to sunlight, etc. Commonly used adulticides are pyrethrum 2 % extract, malathion, permethrin and pyrethrins.

Cold aerosols produce very tiny droplets of high concentrate insecticides used at the time of active period of adult. It is preferred for space treatment because of greater coverage with lesser dosage and no residual effect. Chlorpyriphos and malathion can be used.

Repellents. Mosquitoes are attracted by perspiration, warmth, body odour, Co2 and incandescent light. Repellents can protect humans from mosquito bites for one to five hours, depending on the type used, amount of perspiration, rubbing of the skin and abundance of mosquitoes. Repellents used in commercial products include:

a. N, N-Diethyl toluamide (DEET) acts as repellent than as killing agent. N, N-Diethyl benzamide (DEBA), (Odomos), Diethyl phenyl acetamide (DEPA) are other repellents registered amd popularly available in India.

b. Permethrin is a repellent which can be used as a spray over clothings and it should not be applied directly to the skin.

c. Natural repellents like Citronella and Eucalyptus give protection against mosquito bites for a while.

d. Mats have the synthetic pyrethroid allethrin or its isomers such as prallethrin as the active ingredient (1.2% w/w), e.g., Goodknight, Mortein, Allout. They repel mosquitoes instantly.

d. Coils have d-transallethrin (0.10%w/w) as the active ingredient.

e. Incense stick or agarbathi contains 0.3 % pyrethrum.

f. Refill / liquid / membrane vaporizers are similar to that of the mats with the active ingredient concentration of 1.6 % w/w.

g. Insecticide treated mosquito bednets are treated with repellents, mainly Deltamethrin and Cyfluthrin. Lambdacyhalothrin, alphacypermerthrin and bifenthrin are other alternatives.

h. Paper or plastic strips consist of a substrate (polyurethane, rubber, paper or board) compounded with an ai which vaporizes readily at room temperature (dichlorvos, vapothrin, transfluthrin).

i. Insecticide paints containing Deltamethrin 0.5 % when applied to walls offer protection from mosquitoes for several months.
j. Electronic mosquito repellers are not effective against mosquitoes.
k. Electric fly swatters are used to kill mosquitoes indoor.

Biological Control

Employs microbes as larvicides and larval predators.

Bacillus thuringiensis israeliensis (Bti) is a naturally occurring soil bacterium used for the control of mosquito larvae. Commercial Bti products contain spores and crystal toxins that when ingested by the mosquito larvae release toxins into the gut, causing the larvae to cease eating and eventually dies. Bti specifically controls first to early fourth instar mosquito larvae but is ineffective it controlling pupae or adult, mosquitoes.

Bacillus sphaericus (Bs) is a naturally occurring, spore-forming bacterium found in aquatic and soil environments. The nature and mode of action of Bs is similar to that of Bti. Bs offers advantages over the use of Bti as it introduces live bacterium into the breeding site which is able to multiply in the cadavers of mosquito larvae. Bs is considered to be very specific, exhibits great toxicity against *Culex* and *Anpheles* spp., and provides effective control in polluted water systems.

Predators. The most commonly used biological control agent is the mosquito fish, *Gambusia affinis* and *G. holbrooki*. They do not require any special environment except a dirty water. It should not be reared in natural water bodies like lake, stream, river, etc, because they reduce the amphibian's population. *Poecilia* (guppy) and *Tilapia* are other larvivorous fishes.

Social Awareness

Mosquitos' preference is much lower towards light color cloths than dark coloured one. To some extent loose fitted cloths prevent oneself from mosquito biting. Sleeping inside the mosquito nets totally protect oneself from biting and prevents the entry of mosquitoes. Thus, usage of chemicals is minimized.
1. Refill the water holding containers at least once a week.
2. The inlets and outlets of house openings should be closed with nets like mosquito proof nets especially available in the market.
3. Do not allow pools of water to form in areas like roof gutters.
4. Conduct mosquito protection and disease surveillance programs, if necessary.
5. Increase individual/community awareness of mosquito breeding in septic tanks and of personal and household protection against mosquito bites through promotional activities by government agencies.

Conclusion

On knowing the importance of mosquitoes and disease transmission it's not late to adhere with the principles and methods in full-fledged manner to combat mosquitoes in a war footing way is the timely step one has to take for the well-being and development of the society.

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Influence of Diet and Lifestyle on Leaky Gut

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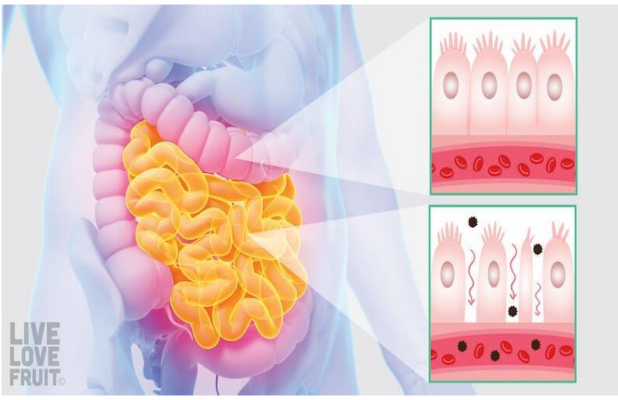
Dr. Snehal Giri[1]
[1]Department of Food Science and Nutrition, UAS, GKVK, Bangalore.

Introduction

The gastrointestinal tract is 30 feet long, continuous muscular tube that runs from the mouth to the pharynx, the esophagus, the stomach, the small intestine, the large intestine, and the anus. The gut "tube" is the interface between the outside and inside of the body. The gut has a major role in food digestion and absorption as well as in maintaining general homeostasis. Normally, the gut has the epithelial cells lining, composed of a monolayer of cells and a thick mucosal gel layer. The lining or gastrointestinal (GI) epithelium functions as a semi-permeable surface to absorb nutrients from food into the bloodstream and also it is the body's greatest barrier and defense against microbes and other invaders. The intestinal barrier is a functional entity separating the gut lumen from the inner host, and consisting of mechanical elements (mucus, epithelial layer), humoral elements (defensins, IgA), immunological elements (lymphocytes, innate immune cells), muscular and neurological elements. The intestinal barrier covers a surface of about 400 m^2.

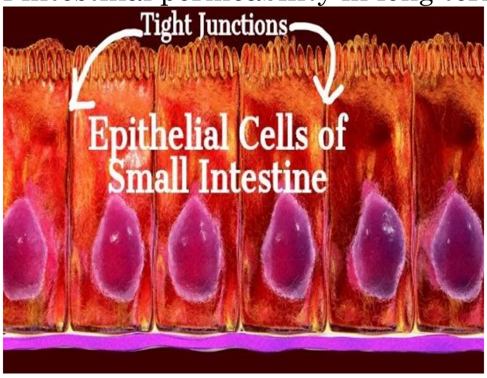


Normal intestinal permeability is a stable permeability found in healthy individuals with no signs of intoxication, inflammation, or impaired intestinal functions. Whereas impaired intestinal permeability disturbed being non-transiently changed compared to the normal permeability leading to a loss of intestinal homeostasis, functional impairments, and disease.

What is Leaky Gut?

Leaky gut develops because of intestinal lining damage. When damage occurs in the intestinal lining, there's not enough protection for the internal environment to filter the nutrients and biological substances.

A compromised epithelium causes a breakdown of the intestinal barrier and disruption of tight junction which causes intestinal hyperpermeability with a noxious effect. Due to the lack of prevention, bacteria, toxins, undigested fats and proteins, and waste can't normally be absorbed, so it will "leak" out of the intestines and flow into the bloodstream. The immune system marks these "foreign invaders" as pathogens and attacks them. This process will trigger inflammation, poor absorption of nutrients, immune dysfunction, and disease. Intestinal permeability or leaky gut terms are often used interchangeably. It is not a well-known medical condition because scanty scientific research studies mention leaky gut. But many research studies showed evidence of intestinal permeability in long term chronic diseases.



Signs and symptoms of leaky gut include indigestion, diarrhea, and constipation, allergies, moodiness, nutritional deficiencies, skin rashes, acne, candidiasis, anxiety/nervousness, chronic muscle/joint pain, impaired, immunity, impaired memory, weight fluctuation, gas, bloating, or flatulence, fatigue, headaches.

Diseases associated with leaky gut include irritable bowel syndrome, inflammatory bowel disease (IBD), Crohn's disease, ulcerative colitis, celiac disease, eczema and psoriasis, fibromyalgia, autism, heart failure, liver disease, food allergy, thyroiditis, rheumatoid arthritis, etc.

How is Leaky Gut Connected to the Immune System?

1. Autoimmune diseases are characterized by tissue damage and loss of function due to an immune response that is directed against specific organs.
2. The lumen of the gastrointestinal tract is outside of the body and much of it is heavily populated with potentially pathogenic microorganisms.
3. Largest presence (70%) of the immune system exists all along the intestine.
4. Aside from all of its other functions, the gastrointestinal tract is a lymphoid organ, and the lymphoid tissue within it is collectively referred to as the Gut-associated lymphoid tissue or GALT.
5. Together with the GALT and the intestinal epithelial barrier, with its intercellular tight junctions, controls the equilibrium between tolerance and immunity to non-self-antigens.
6. However, in a leaky gut, these immune cells are exposed to partially digested food particles that get between the cells.
7. These immune cells then signal these cells to form antibodies to these food particles.
8. Conditions, like irritable bowel syndrome (IBS) and migraines, are partly due to the immune reactions to foods that a person may consume regularly.

Causes of Leaky Gut (Intestinal Permeability)

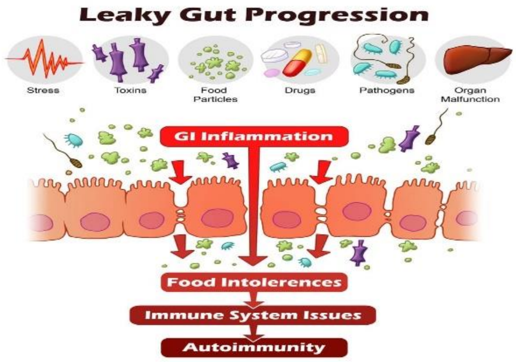
1. Poor dietary choices: High intake of commonly aggravating foods commonly associated with a permeable gut lining. Food additives such as glucose, salt, sugar, emulsifier, caffeine, gluten, dairy, peanuts, and spicy foods, western diet, high fructose diet, high-fat diet, highly processed foods.

2. Nutrient deficiencies: Nutrients required for the integrity of the mucosal cells. Vitamin A, Vitamin D, Quercitin, Calcium, Mg, zinc, antioxidants, protein, and fatty acids deficiencies cause leaky gut.

3. Alcohol: Alcohol is inflammatory. Drinking alcohol in excess can cause significant irritation to an already permeable gut. For someone with a permeable gut lining, alcohol can be very aggravating.

4. Stress and emotions: Physical stress occur due to endurance exercise. Psychological and emotional stress can increase stomach acid production often leading to gastritis/ulcers. Stress may reduce the ability to digest food by reducing the production of digestive enzymes. Stress imbalances the gut bacteria.

5. Infection: Yeast infections such as Candida Albicans. Pathogenic bacterial infections, lack of beneficial bacteria, can cause further damage.



6. Toxic exposure: Pesticides in food, harmful chemicals cause intestinal damage.

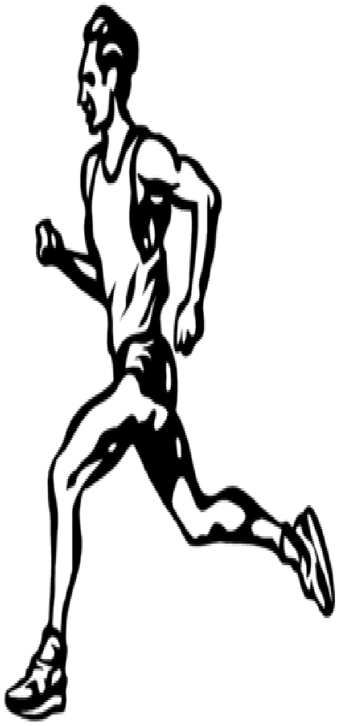
7. Systemic inflammation: It causes the continuous breakdown of cells. Excess inflammation can damage mucosal cells' tight junctions. Too much inflammation stalls the healing process.

8. Improper digestion: Low stomach acid leads to the improper breakdown of proteins and low production of bile leads to the improper breakdown of fats and low levels of digestive enzymes in the intestine leads to larger undigested food.

9. Chronic antibiotics/steroids: Antibiotics, though sometimes life-saving, kill both good and bad bacteria, which upsets the natural balance of the supply of friendly bacteria that keep the gastrointestinal immune defenses strong and resilient. Corticosteroids also have the same effect.

10. NSAIDs: Well-known irritants of the bowel lining are aspirin non-steroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen, naproxen. These medications may cause inflammation of a particular area of the bowel, which may result in ulcers or a permeable gut lining. Antibiotics wipe out beneficial bacteria and therefore may result in infections following treatment.

Exercise and Leaky Gut



1. Increased intestinal permeability is an important issue for those who are doing very intense exercise-to-exhaustion or long duration/endurance exercise because exercise has been shown to draw blood flow away from the gut toward the working muscles to facilitate the movement, a process often referred to as hypo-perfusion (shock).

2. The flow doesn't necessarily get restored quickly enough when the workout is completed.

3. This can lead to increases permeability/leaky gut and also higher rates of bacterial translocation and may lower the efficacy of the immune system and show side effects such as fatigue, electrolyte imbalance, dehydration, cramps, diarrhea, nausea, and an increased risk of infection.

4. Training reduces the ability to absorb and utilize nutrients efficiently is rapidly diminished and the body is being deprived of the building blocks.

5. The GI tract can become even more permeable while running or engaging in other sports that have repetitive up and down mechanical motions.

6. A hot environment can also exacerbate these effects.

Treatment: 4R Gut Restoration Program

1. Remove foods and factors that damage the gut: Goal-To gets rid of all things which negatively affect the gut environment.

a. Identify any food intolerances- food allergens, sugar, fats, GM foods, grains, meat

b. Eliminate toxic and inflammatory foods for a period of time- antibiotics, alcohol, NSAIDS, pesticides, hormones, and certain medications.

c. Elimination diet-All foods that may create allergic or sensitivity reactions should be eliminated for at least 6-10 weeks and then reintroduced slowly to self-test for sensitivity to a specific food group.

d. An elimination diet is the most accurate way to determine how foods affect the digestion, mood, and energy associated with diet.

2. Replace with healing food: Goal- add essential ingredients for proper digestion and absorption.

a. Fermented foods such as sauerkraut, kimchi, yoghourt, kefir, cheese.

b. Eat certain herbs, spices, and supplements to increase digestive enzymes, stomach acid.

c. Bone broth, sprouted seeds, coconut, and foods rich in omega-3 fatty acids are also beneficial.

3. Repair the damage: Goal- Provide nutrients to help the gut repair itself

a. Essential fatty acids - EPA/DHA (fish oil)

b. Amino acids- have been shown to increase electrolyte absorption and improve mucosal barrier functions

c. Vitamins - pantothenic acid (B6), C, A, and especially vitamin D which helps repair the tight junctions that control permeability

d. Antioxidants- such as C, E, beta-carotene, R-alpha lipoic acid

e. Quercitin-stabilizes mast cells that lead to allergic reactions, quells inflammation of the gut, and helps to stabilize tight junctions between cells.

f. Minerals- such as zinc act as the spark plugs for all enzymatic reactions and restore cell membranes.

g. L-glutamine is the primary amino acid food source for the epithelial cells lining the gut.

h. Glutathione - an antioxidant defense against free radical tissue damage.

i. N-acetyl glucosamine (NAG)- promotes the repair of the gut lining.

j. Fiber- in many forms, acts as prebiotic a for probiotic growth and adhesion by providing nutrition for various probiotic species.

k. Low-allergy protein- provides the full complement of amino acids needed for the repair and rebuilding of gut tissue.

4. Reinoculate: Goal-To restore beneficial bacteria and establish a healthy balance

a. Inadequate supplies of good bacteria, plus an overgrowth of bad bacteria, and sometimes yeast. The gut's microbiome can become imbalanced. This condition is called dysbiosis.

b. Experimental data suggest that an imbalance due to disruption of the peaceful co-existence of the intestinal microbiota led to the translocation of bacterial fragments and endotoxemia, which may contribute to a leaky gut.

c. Therefore, need to repopulate the gut with healthy bacteria by eating probiotic and prebiotic-rich foods and supplements.

d. Probiotics help balance the normal flora and rebuild intestinal integrity.

e. Prebiotics and enzymes are often necessary to re-establish helpful bacteria.

Conclusion

The lining or gastrointestinal epithelium functions as a semi-permeable surface to absorb nutrients from food and also it is the body's greatest barrier and defense against microbes and other invaders. Leaky gut develops because of intestinal lining damage so antigens will "leak" out of the intestines and flow into the bloodstream which triggers inflammation, food intolerance, immune dysfunction, and disease. High fat, high glucose or fructose, gluten diet, processed foods, alcohol, smoking, use of NSAIDs drugs, stress are the factors believed to be responsible for leaky gut so therefore need to be avoided to maintain the health of the gut. Increase intake of essential fatty acids such as EPA, DHA, probiotics and prebiotics, high fiber foods, gluten-free diet can help to improve gut health and reduce the risk of leaky gut or intestinal permeability.

Soil Health Management through Organic Agriculture

Article ID: 35166

R. Krupashree[1], T. Theerthana[1], U. Pandu[1], Gurunath Raddy[1]
[1]University of Agricultural Sciences, GKVK Bangalore.

The excessive use of agro-chemicals and higher yielding strains of plant which were high fertilizer responsive after third Agriculture revolution in late 1960's, though helped in increasing agricultural production at early stages, but resulted in deceleration of crop growth and yield. The external input intensive agriculture with the least attention to ecological agricultural principles is not sustainable in long run due to gradual decline in productivity factor and adverse impact on soil health. According to IFOAM, the primary objective of organic farming is the sustainable crop production for maintaining long-term soil fertility in harmony with natural systems. Therefore, to sustain the agricultural productivity and environmental quality, soil health management should be the primary concern. Organic farming system is based on the management of soil organic matter, which in turn maintains the physical, chemical, and biological properties of soil. So, better soil health is inevitable for better growth and development of crop leading to higher production.

Introduction

Excessive use of agrochemicals after green revolution, though it helped in achieving commendable progress earlier, the least attention to ecological agricultural principles resulted in deceleration of growth and crop yield. This is because external input intensive agriculture is not sustainable in long run due to gradual decline in productivity factor and adverse impact on soil health and quality including soil organic carbon It also caused serious concern and chain of several problems in recent decades. Monocropping with indiscriminate use of chemical fertilizers, irrigation and pesticides caused soil degradation, ground water depletion and pollution, ecological imbalance and environmental pollution lead to unsustainability in Agriculture.

According to International Federation of Organic Agriculture Movement (IFOAM), the primary objective of organic farming is the sustainable crop production for maintaining long-term soil fertility in harmony with natural systems. Noticeably, the United Nations Environment Programme (UNEP) sponsored project, Global Assessment of Soil Degradation estimated – more than two decades ago – 38 % of degraded agricultural land globally due to anthropogenic reason Therefore, to sustain the agricultural productivity and environmental quality, soil health management should be the primary concern. Organic farming system is based on the management of soil organic matter, which in turn maintains the physical, chemical, and biological properties of soil. It is now a well-established fact that organically managed soil exhibits greater soil organic carbon and total nitrogen, lower nitrate leaching and biological soil quality, so better soil health is inevitable for better growth and development of crop leading to higher production (Grandy and Kallenbach, 2015 and Cates *et al.*, 2015).

Soil degradation as the process, which lowers the current and/or future capacity of soil to produce goods or services. Soil degradation have impact on our food security and livelihood supporting system and There are grave signs of health risks due to use of agro-chemicals (Hedlund *et al.,* 2003).

Organic farming has potential to maintain soil fertility and increase organic carbon in soil. Application of different organic inputs like FYM, vermicompost, green manuring etc. ensures both the sustainability of soil organic carbon and supply of nutrients to the plants. Application of good quality FYM improves the total nitrogen and organic matter in the soil, which is "an important substrate of cationic exchange and the warehouse of most of the available nitrogen, phosphorus, and Sulphur; the main energy source for microorganisms; and is a key determinant of soil structure". Significant differences and higher values of soil organic carbon, carbon stocks, and carbon sequestration rate were observed in organically managed plots compared to non-organic plots. Biofertilizers are the living organisms capable of fixing atmospheric nitrogen or making native soil nutrients available to crops. Crop residues: application on soil conserve soil and moisture and upon incorporation adds organic matter and nutrients to the soil, during decomposition it makes the other nutrients available for the plant uptake.

Different Organic Practices for Sustainability of Soil Health

Organic fertilizers: Organic acids and humus fraction of decomposing matter are more efficient in releasing phosphorus and reducing its fixation in soil, Nutrient supply through organic sources also ensures micronutrient availability to the plant.

Mulching: It makes the soil softer, pulverized and humid that ultimately helps to maintain bulk density and porosity in the soil. It increases soil fertility, crop production and control soil erosion, residues become decomposed and add organic matter to the soil. Better absorption and less run off-of water in the field. Crop rotation decreases the incidence of soil-born pathogen by increasing soil chemical properties and soil microbial biomass. Pest management through organics, protects crop from pests and diseases and no residual toxicity in soil as well as crop produce.

Effect of Organic Sources of Nutrients on Soil Physico-Chemical Properties

Application of organic manures like FYM, compost, vermicompost, poultry manure with microbial consortia, mulching, green manures etc had positively impacted on soil properties In these reports, soil physical properties like bulk density, water holding capacity, water stable aggregates, hydraulic conductivity, infiltration rate and chemical properties like pH, EC, organic carbon, available nutrients in soil were recorded., Kumar *et al.* (2017), Joshi *et al*. (2016), Loria *et al.* (2016), Meena *et al.* (2015), Abdullahi *et al.* (2015), These organic manures have improved the soil structure through improved organic carbon content which indicates the soil health, these might be due to biological immobilization and continuous mineralization of FYM on surface soil layer, higher organic carbon content which had better soil aggregate and larger macro pore space decreased the bulk density and improved the soil physical properties due to reduced mass per unit of soil and improved nutrient availability in soil.The green manures produce more biomass which maintain the Soil densities, porosity, texture, field capacity and soil moisture and even no tillage or reduced tillage practices. Salahin *et al.* (2013).

During decomposition of organic manures, various phenolic and aliphatic acids are produced which solubilize phosphatase and other phosphate bearing minerals and thereby lowers the phosphate fixation and increase its availability, Available K in soil increased with the application of organic manures which is due to solubilising action of organic acids produced during FYM decomposition and its higher capacity to hold K in available form. organic manure improves porosity and hydraulic conductivity which might have resulted in enhanced leaching of the salts thereby reducing the EC values. Crop residue mulching and organic manures in combination have enhanced the soil available nutrients and improved the soil physical properties by increase multiplication of soil microbes leading to enhanced conservation of organically bound N into inorganic forms and rapid mineralization, their solubilizing effect on native insoluble P fraction through release of various acids, thus resulting into a significant improvement in available P status of soil addition of organic matter that reduce K-fixation and release K and sulphur due to interaction of organic matter with clay (Ghosh *et al*., 2006).

Effect of Organic Inputs on Biological Properties of Soil

Along with soil physical and chemical properties, biological properties is also play a important role in assessment of soil quality for the sustainable production. (Kramer, 2002). Biological property of the soil indicates microbial biomass (microflora, microfauna, macroflora and macrofauna). Researchers have showed the positive effects of application of organic inputs in enhancing the soil microbes which includes soil arthropods (Babalad *et al.*, 2011), bacteria, fungi, actinomycetes population (Kiran *et al.,* 2015; Meena *et al.,* 2015).

Crop rotation with residue management have enhanced the enzyme activity like dehydrogenase, fluorescein diacetate (FDA) and alkaline phosphatase activities. FDA is a measure of organic matter turnover (Green *et al*., 2006), dehydrogenase activity may be explained due to greater availability of nutrients for microbial metabolism. alkaline phosphatase activity due to the input of residue is important for the transformations of P and vital to maintaining plant available pool of soil P.

The major contributors of soil enzyme pool are mainly microorganisms. Soil enzyme originate from soil microorganisms. Enhanced microbe load in soil increases the enzymatic activity in soil like urease, dehydrogenase and phosphatase activity in the soil. Krishnakumar *et al.* (2005), Patel, 2015.

Conclusion

To achieve sustainable crop and livestock production, the primary requirement is the maintenance of soil fertility and soil health. Organic farming being integrated biological systems could be the potential technology option to maintain good soil heath. Organic practice has both direct and indirect effect to soil properties as it affects more than one component of the system simultaneously.

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Water Soluble Fertilizers

Article ID: 35167

T. Theerthana[1], R. Krupashree[1], U. Pandu[1], Gurunath Raddy[1]
[1]University of Agricultural Sciences, GKVK Bangalore.

Introduction

Water soluble fertilizers are the fertilizers which are completely soluble in water and leave no residue in the water. These are having different soluble nutrients grades available in the powder or liquid form. These fertilizers are applied to crops through fertigation and foliar spray for efficient use of nutrients leading to better yields and quality.

The 100% water soluble fertilizers can be defined as the NPK, NP, NK, NCa and KMgS, etc. grades of fertilizers which are completely soluble in water and can be applied in the crops. These fertilizers have been included in Fertilizer Control Order (FCO), 1985.

Enhancing sustainable food productions and export business require proper use of available land, water and fertilizers which includes:
1. Scientific usage of foliar nutrition with water soluble fertilizers.
2. Agricultural intensification with emerging concept of foliar and fertigation nutrition.

With water soluble fertilizers, it is easy to control the precise amount of nutrients available to the plants. The use of WSF in different crops is major in India while these are mainly used in developed countries. These are primarily utilised as foliar sprays or drip fertigation systems in India. So far, the most important use of foliar application has been in micro nutrients.

The more challenging part of delivering N, P, and K through foliar spray is getting enough of each without badly burning the leaves. Nutrient quantities supplemented through foliar feeding should not exceed 2% to avoid injury due to foliage and also to ascertain economic feasibility. As multiple micronutrients deficiencies are being frequently cited in Indian soils indicating that deficiencies are wide spread and showing increasing trend. This situation necessitates fortifying micro nutrients with high analysis products of major nutrients.

Nutrient treatment *via* foliar sprays, in addition to soil application, has a number of advantages in terms of augmenting crop nutritional needs. Foliar feeding is intended to address issues such as nutrient fixation and immobilisation. Foliar nutrition is thus becoming a recognised form of fertilising in modern agriculture.

This approach allows for more effective nutrient consumption and rapid correction of deficits. For foliar application, specialty fertilisers are a preferable option. These fertilisers include various N, P, and K ratios that are extremely water soluble and thus suitable for foliar nutrition (Jayabal *et al.*, 1999).

Characteristics of Water-Soluble Fertilizers

1. The nutrient element must be present in readily available form to the plants.
2. High purity, fully soluble fertilizer, composed entirely of plant nutrients.
3. P and K are in assimilable forms (K^+ and $H_2PO_4^-$).
4. Have lowest salt index.
5. Sodium and chloride free.
6. No heavy metals.
7. Balanced nutrient composition.

Comparison Between the Conventional Fertilizers and Water-Soluble Fertilizers

Properties	Water soluble fertilizers	Conventional fertilizers
Solubility	Readily soluble in water	Nutrient may be in soluble form carrier material not fully soluble

Uniformity of nutrient ions	Ionic distribution uniforms depending upon concentrations & composition of base material used	Ionic distrib ution not uniform
Solubility time for preparation of solution	1 to 4 minutes in water	12 to 24 hours 25° C
Filtration of solution before application	Not required	Filtration is required
Salt index	8 to 40	It varies
Nutrient use efficiency	Very high	Higher if applied in split
Cost	High	Less compared to WSF

FCO Approved Water-Soluble Fertilizers

Sl. No.	Fertilizer	Grades
1	Potassium nitrate	13-0-45
2	Mono potassium phosphate	0-52-34
3	Calcium nitrate	15.5-0-0
4	N-P-K	13-40-13
5	N-P-K	18-18-18
6	N-P-K	19-19-19
7	N-P-K	13-5-26
8	N-P-K	6-12-26
9	N-P-K	20-20-20
10	Mono ammonium phosphate	12-61-0
11	N-P-K	17-44-0
12	Potassium magnesium sulphate (K-Mg-S)	22-18-20

Methods of Application of Water-Soluble Fertilizers

1. Starter solutions.
2. Foliar application.
3. Drip fertigation.
4. Injection into soil.
5. Aerial application.

Advantages of Water-Soluble Fertilizers

1. WSF is available in two forms: foliar and fertigation. Depending on the application, they can also be used in the soil.
2. Minimizing soil pollution, soil and water erosion are prevented.
3. Wide ranges of nutrient grades are available.
4. Fertilizer use efficiency is more than the conventional methods.
5. Reduced labour input.
6. Wide ranges of nutrient grades are available.
7. Even distribution of nutrients throughout the root zone.
8. Timely application nutrients possible.
9. Fertilizer use efficiency is more than the conventional methods.

Limitations of Water-Soluble Fertilizers

1. Good quality water is very essential.
2. Costly and limited availability of water-soluble fertilizers.
3. Infestation of insects' pest and diseases increase.
4. Have scorching effect if used at higher dose.
5. High cost of initial investment.
6. Can't be pressurized for smaller area.

Future Line of Work

1. There is a need to standardise the best dosage of water-soluble fertilisers that are commercially available for foliar nutrition in various pulse and oilseed crops. Need to study the compatibility of water-soluble fertilizers with insecticides in pulse and oilseed crops
2. Popularization of water-soluble fertilisers that are commercially available for foliar nutrition in Indian Agriculture.

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The Impact of Stubble Burning and Poor Air Quality in India During the Time of COVID-19

Article ID: 35168

Amrinder Singh[1]
[1]Assistant Professor, Department of Agriculture, Desh Bhagat University, Mandi, Gobindgarh, Punjab-147301.

Abstract
Burning of crop residues released many pollutants, resulting in serious health hazards. This paper is an attempt to explore status of crop residues burning in Northwest India and its consequences on health in general and on child health in particular. An effort has also been made to find out the correlation between stubble burning and increasing incidence of acute respiratory infection (ARI) among children in Punjab. As the world works to fight the spread of the coronavirus crisis, it is important to not only consider the human health as part of the response, but also planetary health. This includes minimizing additional risks such as poor air quality, which is linked to a number of respiratory illnesses and may exacerbate symptoms related to COVID-19 and add burden to the already stressed health infrastructure. From October to December 2020, air quality in New Delhi and other cities in north India reached up to 20 times higher than the safe threshold levels defined by the World Health Organization. It has also been observed that the phenomenon of stubble burning is quite high in Punjab with comparison to other northwest Indian states resulting into increase in incidence of ARI among children.

Keywords: Crop Residue, Stubble Burning, Acute Respiratory Infection, Air Quality Index.

Introduction
Agriculture sector has always been the pivotal sector to the sustainable growth and development of Indian economy. During Green Revolution, high yielding variety (HYV) seeds had been introduced in the system which extensively increased the productivity, cropping intensity of land and per capita income of farmers. About 40 MT of paddy straw is generated in the north-west India of which Uttar Pradesh, Punjab, Haryana are the major contributors.

Uttar Pradesh, Punjab and Haryana produced 20.67Mt, 19.70Mt and 6.86Mt rice straw respectively (CESD 2017). One kilogram of paddy generates 1-1.5 kilogram of straw. In these states, about 80 percent rice straw sets to fire in fields and of the total open field burning, 48% is contributed by Punjab and Haryana alone. (Gadde *et. al.,*2009).

Last year, according to researchers at the Indian Institute of Tropical Meteorology (IITM), Pune, the onset of stubble burning in Punjab and Haryana coincided with a tenfold increase in daily COVID-19 cases in Delhi. Prolonged exposure to air pollution also leads to a rise in mortality rates, as per the study by IITM, and the life expectancy of Delhi inhabitants has decreased by about 6.4 years due to their exposure to high levels of pollution. Delhi and 14 other cities (primarily in Uttar Pradesh and other northern states) make it to the list of 20 most polluted cities globally, and the burning of 5.7 million acres of rice paddy stubble every year is attributed as a significant cause. The practice of crop stubble burning impacts soil quality as well.

The high temperatures kill the nutrients and microbes in the soil, and farmers have to spend additional money on restoring its health by spending on more fertilizers. Farmers are aware of the negative implications of incinerating the crop stubble, but a lack of viable options forces them to burn their fields. Modern harvesting practices leave stubbles 5-6 inches high and require machinery like a bailer or a Happy Seeder to plough it through. However, these being costly investments with limited usage, the small and medium holding farmers (75 percent of India's farmers own a hectare or less) resort to burning crop stubble as the only alternative. Also, any delay in handling leftover stubble impacts their next sowing cycle, which has a cascading effect on the subsequent yield and, ultimately, their income. Recognizing the gravity of the situation, the Indian Agriculture Research Institute (IARI) developed a bio-enzyme, called PUSA, which decomposes the stubble, turning it into organic manure. The product was revolutionary but needed to be provided in commercially viable packaging and easy-to-use formula. Public-private collaboration to mobilize and scale up the entire operation was required to take this cost-effective solution to the grassroots.

For this, firstly, a strategy for easy implementation and use of PUSA by the farmers was devised. The PUSA decomposer was converted into a spray, 250gms of which was enough for one acre of land. Being a biological material, special attention has to be paid to the mixing procedure - it should not be exposed to the sun, and an adequate amount of moisture content has to be maintained for the decomposition of stubble to happen. For this, the soil needs to be rotated by a rotavator, and the field must be sufficiently irrigated for the next 3-4 days. If all the safeguards are followed, the land is ready to be sown with the next cycle of seeds in just eight days. Since the fungi consortia decompose only the dead mass, the living plant seed does not get affected by its activity. Once the basic steps to be followed were made clear - Spray (PUSA) +Turn (the soil) + Irrigate, the solution was ready to be taken to the farmers.

Burning Crop Stubble

Residue burning is a major source of health hazards like asthma, bronchial asthma, acute respiratory infection (ARI) and irritation in eyes. India has the highest number of blind people in the world and from every three cases of cataract in the world one is from India. Eye watering, eye irritation, conjunctival hyperemia are symptoms associated with exposure to smoke (Arbex M. *et. al.,* 2004). With the onset of winter, farm fires become rampant in northern India, particularly in the states of Punjab, Haryana and western Uttar Pradesh.

The problem of poor air quality is exacerbated in the already disadvantageous landlocked Delhi, where pollutants get trapped, unlike in coastal cities where they are swept out to sea. Over the years, parts of Punjab, Haryana and Uttar Pradesh have moved to specialized short-duration varieties of rice-wheat cropping systems. With the adoption of these varieties – rice crops (June/July to October/November) followed by wheat crops (November/December to March/April) – rotation has become popular in areas which earlier produced only wheat or rice in any one farming year.

However, this cropping system – perceived as “efficient” – has come at a huge environmental and health cost. The main reason for paddy (rice crop) stubble burning is the short time available between rice harvesting and sowing of wheat; a delay in sowing wheat adversely affects the wheat crop. The short timeframe available between rice and wheat crops can also be attributed partly to the 2009 Punjab Preservation of Subsoil Act, where paddy transplantation date is fixed for June 20 which pushes ahead the harvesting of rice crop.

In a recent initiative by the government of Punjab, a two-year plan has been framed which includes expenditure of Rs 665 crore to provide 80 percent subsidy on straw management machinery to cooperative societies and groups and 50 percent subsidy to individual farmers (Manish Sirhindi, TOI, August 30, 2018).

Government Subsidy Helps Farmers

Although the technology itself is not new, it was up until recently prohibitively expensive, with a happy seeder costing around 150,000 INR (almost €2,000). With around 80% of farmers in Haryana owning under 5 acres of land, the majority cannot afford to invest.

Now, however, a central government scheme is investing over 11b INR (€140 million) in three states over a two-year period, with the aim of reducing crop residue burning by providing subsidies to farmers buying the machines. Organizations like CIMMYT are working alongside state governments to train farmers and promote the new technology, in an attempt to both increase grain productivity and reduce economic and labor inputs required by the farmers.

Vikas Chaudhary, 39, a beneficiary of the plan who owns 14 hectares of land just outside Karnal, Haryana, says that his input cost has decreased from 3-4 thousand rupees per acre to just over 1,000 since he started using the happy seeder. "Everyone said I was a mad farmer, I will never get a good yield with the field full of straw," Chaudhary says. "But I am very happy. I am saving time and energy."

Happy seeder machine used to sow wheat in Karnal

1. Biomass Depots: It is essential to undertake on-field baling of stubble, aggregate bales in a depot and enter into "bankable" agreements for supplies to Bio-Energy Plants. There should be fiscal incentives (capital subsidy from MNRE and interest subsidy from state governments) enabling green entrepreneurship.

2. Biomass Power Plants: The Punjab Energy Development Agency has actively supported the biomass power sector, including provisioning for a high feed-in tariff of Rs8/ KWh, but capacity creation, as well as stubble consumption, is relatively low. A sharp decline in solar and wind tariffs, though, is a constraint. The costs of establishing a year-round "bankable" supply chain for paddy straw bales is another deterrent.

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Growing Plants Without Soil: Hydroponics

Article ID: 35169

Veerendra Jaldhani[1], Srikanth Bathula[2]
[1]Crop Improvement Section, IIRR, Rajendranagar, Hyderabad.
[2]Crop Physiology, PJTSAU, Rajendranagar, Hyderabad.

Plants need certain basic components to grow well. These components include seeds, soil, water, sunlight etc., Plants get all the essential nutrients through the soil. But in today's concrete world filled with flats and apartments, getting a place with good soil to grow the plants is impossible. There are alternative techniques to grow plants without soil. Hydroponics is one of the ways to show your affection towards the plants. This is an innovative technique to grow plants without soil.

What is Hydroponics?

Hydroponics is the method of growing plants without soil, using mineral nutrient solutions and water. The roots of the plants are immersed in the water containing nutrient solution. The nutrients provided to the plants in hydroponics are mostly the byproduct of fish waste, duck manure, or normal nutrients. The word Hydroponics has derived from Greek words where Hydro means 'Water' and ponos means 'Growth'.

Hydroponic Culture

An author and botanist named Francis Bacon was the first person who started the Hydroponic system. In the year 1627, he wrote a book called 'Sylva Sylvarum' which contained the details about growing a terrestrial plant without soil. Since then, many research was conducted to study about hydroponics. In 1699, another author named John Woodward published an article about water culture experiments with spearmint. He had grown two plants, one in normal water and another in pure distilled water. He found that the plants which were grown in normal water sources grew better than plants in distilled water.

Two German botanists named Julius von Sachs and Wilhelm Knop conducted an experiment from 1859 to 1875 and came up with a list of most essential components to carry out Hydroponics. This gave a big positive impact towards the development of soilless cultivation of plants. The growth of terrestrial plants without soil in mineral nutrient solutions was then called as solution culture. Many research and teaching technique were conducted and is still widely used as a growing technique. Solution culture is now considered as a type of hydroponics where there is no inert medium.

How do the Plants Grow in Hydroponics?

The plants are provided with required nutrients for its growth. If you give a plant exactly the nutrients it needs at the right time in a correct quantity, the plant will be as healthy as is genetically possible. With hydroponics, this is an easy task compared to soil. The plants are grown in an inert growing medium and a perfectly balanced, pH adjusted nutrient solution is delivered to the roots in a highly soluble form. This allows the plant to absorb the required nutrients with very little effort when compared to soil where the roots must search out the nutrients and extract them. This is true even when using rich, organic soil and best nutrients. The energy expended by the roots in this process is energy better spent on vegetative growth and fruit and flower production.

If you grow two plants of the same kind using soil for one and hydroponics for the other, you will almost immediately see the difference in their growth. You can find faster, better growth and comparatively good yield from hydroponics. These are the reasons that hydroponics method is adopted for commercial food production as well as by hobby gardeners at home.

Types of Hydroponics

There are many types of hydroponics used across the globe. Some of the best hydroponic systems are made of different types of hydroponics into one hybrid hydroponic system. Here are some of the easy and commonly used techniques.

1. Deep water culture method: Deep water Culture method which is also known as the reservoir method is one of the easiest methods for growing plants with hydroponics. In this method, the roots are suspended in a nutrient solution. An air pump is introduced to oxygenate the nutrient solution in order to avoid the roots of the plants from drowning. You need to prevent direct sunlight from penetrating the system, as it can support algae growth and hence the whole system gets affected. The primary benefit to using a Deep-water Culture method is that there are no drip or spray emitters to clog. This makes the system a perfect choice for organic hydroponics, as hydroponics systems that use organic nutrients are more prone to clogs.

2. Wicking method: The Wicking method is one of the simplest types of hydroponic system. This is a passive system, hence there are no moving parts in the system. The concept behind wicking is that you have a material such as cotton that is surrounded by a growing medium with one end of the wick material placed in the nutrient solution. The solution is then wicked to the roots of the plant. The nutrient solution is drawn into the supporting medium from the reservoir using a wick with one end dipped in the reservoir and the other end connected to the supporting medium. This system can use a variety of supporting medium such as Perlite, Vermiculite, and Foam with a hole in the center etc. The roots pass through the gap in the supporting medium to obtain the nutrients.

3. Nutrient film method: This is the most commonly used hydroponics method across the world. This system has a constant flow of nutrient solution so no timer required for the submersible pump. The nutrient solution is pumped into the growing tube and flows over the roots of the plants, and then drains back into the reservoir. The nutrient solution is on a slight tilt surface so that the solution will flow with the force of gravity. This type of system works very well because the roots of a plant absorb more oxygen from the air than from the nutrient solution itself. Since only the tips of the roots come in contact with the nutrient solution, the plant is able to get more oxygen which helps in a faster rate of growth. There is usually no growing medium used other than air, which saves the expense of replacing the growing medium after every crop. Normally the plant is supported in a small plastic basket with the roots suspended into the nutrient solution.

4. Dripping method: Dripping method is probably the most widely used type of hydroponic system in the world. A timer controls a submerged pump in the nutrient solution. The timer turns the pump on and nutrient solution is dripped onto the base of each plant by a small drip line. In a Recovery Drip System, the excess nutrient solution is collected back in the reservoir for re-use. A recovery system uses nutrient solution a bit more efficiently. As the excess solution is reused, this also allows for the use of a more inexpensive timer because a recovery system doesn't require precise control of the watering cycles. A recovery system can have large shifts in the pH and nutrient strength levels that require periodic checking and adjusting.

When it comes to the non-recovery system, it needs to have a more precise timer so that watering cycles can be adjusted to ensure that the plants get enough nutrient solution and the runoff is kept to a minimum. The non-recovery system requires less maintenance due to the fact that the excess nutrient solution isn't recycled back into the reservoir, so the nutrient strength and pH of the reservoir will not vary. This means that you can fill the reservoir with pH adjusted nutrient solution and then forget it until you need to mix more.

Advantages

1. It can increase the rate of growth in your plants. With the proper setup, your plants will mature up to 25% faster and produce up to 30% more than the same plants grown in soil.
2. Your plants will grow bigger and faster because they will not have to work as hard to obtain nutrients.
3. The root system gets the exact nutrients that it needs, so the plant will focus more on growing instead of struggling to absorb the nutrients.
4. A hydroponic system will also use less water than soil-based plants because the system is enclosed, which results in less evaporation.
5. The hydroponic system reduces waste and pollution from soil runoff as it does not use soil medium for the growth.

Disadvantages

1. The quality hydroponics system of any size will cost more than its soil counterpart.

2. A large-scale hydroponics system can take a lot of time to setup.
3. You will have to monitor and balance your pH and nutrient levels on a daily basis.
4. The pump failure can kill off your plants within hours depending on the size of your system.
5. The plants die quickly if the growing medium can't store water like soil as the plants are dependent on a fresh supply of water.

Conclusions

In recent years hydroponics is seen as a promising strategy for growing different crops. As it is possible to grow short duration crop like vegetables round the year in very limited spaces with low labour, so hydroponics can play a great contribution in areas with limitation of soil and water and for the poorer and landless people. In India, the hydroponic industry is expected to grow exponentially in near future. To encourage commercial hydroponic farm, it is important to develop low-cost hydroponic technologies that reduce dependence on human labour and lower overall start-up and operational costs.

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Contribution of Wild Edible Plants in the Rural Economy of India

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Khulakpam Apshahana[1], Dr. A. K. Sharma[2]
[1]PhD Scholar, Non-Timber Forest Products Discipline, Silviculture and Forest Management Division, Forest Research Institute, Dehradun-248006, India.
[2]Former Head and Scientist – F, Non-Timber Forest Products Discipline, Silviculture and Forest Management Division, Forest Research Institute, Dehradun-248006, India.

Introduction

Wild edible plants (WEPs) have been used by ethnic communities all over the world for a variety of purposes since the beginning of time, including food, medicine, livelihood, cash income, cultural, and religious purposes. The plants species that are neither cultivated nor domesticated, but grow wild and are edible are term as Wild edible plants (Beluhan and Ranogajec, 2010). The term is sometimes applied to exotic, undervalued, or ignored plants that are less well-known.

Wild edible plants supplement energy by adding extra calories to diets, adding qualitative aspects, and supplementing micronutrients to rural populations (Bell, 1995; FAO, 2005). Millions of people lack adequate nutrients to meet their daily needs in several developing countries, and millions more are lacking in one or more nutrients (FAO, 2004) and this is also true in India, the world's second most populous country.

In India, the majority of rural dwellers rely on wild edible plants to supplement their diet. Wild plants diversity adds variety to the family's diet and helps to ensure food security in the households. The world's largest producer and consumer of NWFPs is Asia. China and India are by far the largest producers and consumers of various NWFPs in the world. China leads the world in NWFPs trade, followed by India, Indonesia, Vietnam, Malaysia, the Philippines, and Thailand (FAO, 2000).

Categorization of Wild Edible Plants

Fruits, seeds, medicinal and aromatic plants, resins, honey, gum, bamboos, and canes are among the many natural resources found in India's forests. WEPs were classified by Singh and Arora (1978) into a few broad types based on the consumed plant parts such as the roots/tubers, leaves and shoots, flowers, ripe and unripe fruits, and the seeds, nuts and kernels

1. Edible Underground Parts of Plants: *Curcuma spp*., *Colocasia spp., Alocasia spp*., *Zingiber spp*., etc.

2. Plants with Greens leafy vegetables: *Portulaca oleracea, Chenopodium album, Amaranthus spinosus* etc.

3. Edible Flowers species: Edible flowers, buds, inflorescences, etc. e.g.*, Madhuca longifolia, Bauhinia species, Alpinia galanga, Capparis spinosa, Rhododendron arboreum* etc.

4. Edible Fruits species: *Zizyphus mauritiana, Elaeagnus spp., Elaeocarpus spp. Artocarpus, Fragaria spp*., etc.

5. Edible Seeds: Seeds, nuts and kernels, e.g., seeds of *Artocarpus heterophyllus, Sterculia spp., Parkia roxburghii* etc.

6. Other Edible type: Bark of *Cinnamomum zeylanicum, Betula alnoides, Terminalia tomentosa* etc.

Significant of Wild Edible Plants (WEPs) in Rural Livelihood

India's rich biodiversity of 45,000 plant species is distributed across 16 agro-climatic zones, covering about 23.38 percent of the country's total geographical area (FSI, 2001), and accounts for 8% of the world's known biological diversity. More than 3000 plant species can be found in India's forests (Negi, 1994), which produce a wide range of non-wood products.

Fruits, seeds, medicinal and aromatic plants, resins, honey, gum, bamboos, and canes are among the many natural resources found in India's forests. The tribal communities in India consumed about 800 species of wild edible plants (Singh and Arora, 1978).

There are nearly 500 million people living in and around the forests who rely on supplementary income from NTFPs to survive, with 5 million of them are tribals (Rawat and Jishtu, 2006). In different seasons, rural people around the world rely on a variety of edible wild plants to supplement their dietary and sell or barter them in local markets for cash requirements or household items.

They are important for household food and nutrition security in some rural areas, especially dry lands and bridging seasonal food scarcity and providing emergency supplies during difficult times. WEPs are vital to rural communities as a source of income, particularly for those who live in areas that are unsuitable for crop production.

Selling of edible fruits, leaves, flowers, roots, rhizomes, shoots, stem piths and its products like juice, pickles and local drinks etc provides income and employment to the rural poor. Many researchers revealed that the nutritional quality of wild plants is similar and, in some cases, even superior to domesticated species (Addis *et al*., 2005; Balemie and Kebebew, 2006).

Various WEPs have also been linked to the treatment or prevention of diseases like malnutrition, heart disease, cancer, and diabetes. 17% of landless people rely on daily wages from NWFPs collection. NTFPs accounts for more than half of the forest department's revenue. Its growth rate is typically 40% greater than that of timber (ICFRE, 2000).

The share of income earned from the sale of NTFPs differs from state to state and is projected to be between 5.4 per cent to 55 per cent (Khare *et al*., 2000). Women's workforce in forest-based enterprises is predicted to be around 571.533 million days per year, with 90 percent of that time spent in small-scale businesses that use NTFPs (Khare, 1987).

Conclusion

WEPs are now universally acknowledged for their role in ensuring food and nutritional security, rural economic stability, diversification, poverty reduction for rural and indigenous communities. Unfortunately, data available on nutritive values or consumer preferences is limited or even less recorded.

Unsuitable regulation of WEPs occurs in many ways, ranging from unrestricted open access, which can result in unsustainable extract rates and deterioration of vegetation in the forest. The collection and sale of WEPs for extra income have a larger impact on the rural tribe economy.

Recognizing the role of WEPs in household food security, it is important that the social-ecological systems that allowed the collection of these natural resources be adequately safeguarded, managed, and treasured in order to avoid overexploitation and degradation. There is indeed a significant amount of work to be done in order to develop, promote and marketing of WEPs. As a result, there is an immediate need for sustainable management, along with promotion and domestication for WEPs species.

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CRISPR/Cas9: Gene Editing Tool for Improvement of Vegetable Crops

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Shaina Sharma, Sanjay Chadha, Amit Kumar

Vegetable crops are rich in minerals, vitamins and dietary fibre which are important to human health. However, many biotic and abiotic stresses threaten the growth, quality and yield of crop. Traditional breeding strategies for improving crop traits include a series of backcrosses and selection to introgress beneficial traits into fine germplasm but this process is slow and resource-intensive. The new breeding technique known as clustered regularly interspaced short palindromic repeats (CRISPR)-CRISPR-associated protein-9 (Cas9) has the potential to improve many traits quickly and precisely, such as yield, quality, disease resistance, abiotic stress tolerance, and nutritional aspects.

The acronym CRISPR, (first coined by Jansen et al., 2002). The CRISPR system is adaptive immune mechanism present in bacteria and Archaea for defense against invading bacteriophages and exogenous plasmids. It was first discovered in the genome of *Escherichia coli* (Ishino et al.1987). The discovery of CRISPR/Cas9 gene editing system has revolutionized research in animal and plant biology with its utility in genome editing being first demonstrated in mammalian cells (Jinek et al., 2012).

Requirement for CRISPR Cleavage

1. A short gRNA sequence (20 nucleotides) that bind to the target DNA.
2. Cas9 nuclease enzyme (cleaves 3–4 bases).

Steps:

a. Identification of PAM sequence in the target gene
b. Synthesizing a single gRNA
c. Cloning the sgRNA into a suitable binary vector
d. Introduction into host cell lines transformation
e. Screening
f. Validation of edited lines.

Most of the CRISPR/Cas9 experiments are done in tomato where 18 different genes have been targeted independently. The first CRISPR/Cas9-mediated genome editing in vegetable crops was reported in tomato (Brooks et al., 2014).

Prolonged shelf-life is an important breeding goal in vegetable production. CRISPR has been used to knock out ripening inhibitor (RIN) or DNA demethylase to slow fruit ripening in tomato, thereby prolonging their shelf life.

CRISPR-Cas9 can be used to reduce the content of substances in vegetables that are not conducive to human health, by targeting mutations that inactivate genes in biosynthetic pathways. For example, in potato tubers, excessive content of steroidal glycoalkaloids (SGAs), such as solanine and chaconine, affects their taste and makes them less safe for human consumption, hence low content is an indicator of high quality.

CRISPR-Cas9 has been used to delete St16DOX (steroid 16_-hydroxylase) in the potato SGA biosynthetic pathway, resulting in SGA-free potato lines.

Conclusion

CRISPR/Cas9 based genome editing technique is helpful in vegetable improvement to enhance yield, nutritional value, disease resistance and other traits and will be area of work in the future.

This technique is now becoming popular and will be an essential gene editing tool to obtain 'suitably edited' plants that will help to achieve the zero-hunger goal and will feed the entire growing human population.

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Information about Thumbai

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Rajakumari Malliga M[1]
[1]Assistant Professor, Soil Science and Agricultural Chemistry, Imayam Institute of Agriculture and Technology, Kannanur, Thuraiyur, Trichy, Tamil Nadu- 621 206.

Introduction

Medicinal plant includes various types of plants used in herbalism. It is the use of plants for medicinal purposes. Herb refers to any part of the plant like fruit, seed, stem, bark, flower, leaf, stigma or a root, as well as a non-woody plant. These medicinal plants are also used as food, flavonoid, medicine or perfume and also in certain spiritual activities. There are so many different plants in the places where we live that we wonder if they are such an herb. One of them is the thumbai plant. Its botanical name is Leucas Aspera and it is found all over India extensively. Both the flowers and leaves are used in home remedies. Thumbai poo is a tiny, white flower that grows in bunches of a bulb. It is a small roadside plant which grows wildly in abundance. It is called as Thumbai poo (Tamil), Thumbe hoovu(Kannada), Thumba Poo(Malayalam) and Thummi poovulu(Telugu) dronapushpi (Sanskrit), darunaphula (Bengali), goma madhupati (Hindi) and Kubo (Sindhi). There are many types of thumpai such as Perumthumbai, Siruthumbai, Malaithumbai, Kavilthumbai, Kasapputhumbai, Donkey Thumbai, Black Thumbai, Ghost Thumbai and Kasithumpai. They are widely used in Ayurvedic medicine and handicrafts. It can also be used as an internal topical ointment. Tumbai is one of the ancestral uses for summer cooling. Let's look at diseases that can be cured with turmeric.

Major Chemicals in Thumbai Plant

Thumbai exhibits and array of chemically bioactive components including ***laballenic acid, beta sitosterol, oleanolic acid, 7- oxostigmasterol, 7- oxostitosterol, 7- alpha hydroxyl stigmasterol, pillion, gonzalitosin I, tricin, cosmosin, anisofolin and lureolin*** etc.

Uses of Thumbai

It is commonly used as an insecticide, antifungal, prostaglandin inhibitory, antioxidant, antimicrobial, antinociceptive and cytotoxic activities. In addition, the plant also has been used in witchcraft.

1. Scorpion sting: In scorpion sting the plant is used internally as well externally. The leaves juice (few drops) is mixed with honey and taken orally.

2. Thumbai Juice: To makes the juice, take the leaves and grind it to a smooth paste along with little boiled water. Take around 1 tbsp of the juice for 3 days in an empty stomach daily to speed up the healing process. This juice also can be applied for skin problems. This juice also removes intestinal worms.

3. Skin diseases: The leaves juice is used topically in psoriasis, skin eruption, and scabies and internally for the treatment of urinary complaints. The flowers are administered in the form of syrup or with honey for cough and cold.

4. Skin diseases, removing blood toxins: Skin diseases mainly occur due to toxins in blood. Dronapushpi plant has ability to flush the toxins from body. In skin diseases, whole plant of thumbai is used. Skin diseases (itching, patchy skin, psoriasis, scabies etc.). The paste of leaves is applied externally at the affected body areas.

5. Abnormally heavy bleeding at menstruation: The leaves of plant is taken a handful. These are washed and then ground to make fine paste. This paste is mixed with lemon juice and sesame oil/til oil (edible). The preparation is eaten empty stomach every morning for a week.

6. Excessive thirst: The flowers (2 tablespoon) are boiled in water (150 ml) till volume reduces to half. This is filtered and taken thrice a day.

7. Cough leucorrhoea: The leaves of plant are cooked and eaten with rice. Cough, congestion, blockage of nose, headache due to cough, Sinusitis, Migraine, Phlegm the juice of leaves is put in nostrils as drops.

For this purpose, the leaves juice is extracted and mixed with two times water. Then the diluted juice is put in nostrils (4 dops) for 3-4 days. The flowers are heated in til/sesame oil and applied on head.

8. Fever (acute, chronic), Allergy: The decoction of plant (2-3 grams in boiled in two glass water till water reduces to one fourth) is used

9. Food: It is a herb used in food to provide fragrance to food.

10. Thumbai oil for oil Bath & Noise in the Ear: If you are suffering from sinusitis and if this problem is keeping you from having oil bath, try the oil made with thumbai flowers. To make the oil, heat unrefined sesame oil in a small pan along thumbai flowers in a low flame. Fry till the flowers are cooked well and strain, use this oil for having oil massage. This oil also prevents sinus headaches. A drop of this oil in each ear will prevent the noise in the ears that I mentioned earlier.

11. Asthma, cold, cough: The leaves juice of plant is taken in dose of 1-3 teaspoons.

12. Insect Bites & Skin Diseases: Take the leaves of the plant and pound it as finely as you can in a mortar and pestle and apply it as a poultice over the affected area. Take a thin cotton cloth and tie it over the poultice to prevent it from falling down and also make sure not to add any water or very little water while pounding the plant.

	
Perum thumbai	**kavil thumbai**
	
Thumbai plant	**Kasithumbai**

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Guava Juice and its Nutritional Benefits

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Sanjaikannan A[1], Leena Sree R[1], R. Arunkumar[2]
[1]Assistant Professor, Department of Agricultural Engineering, SRS Institute of Agriculture and Technology, Vedasandur.
[2]Assistant Professor, Department of Agricultural Extension, SRS Institute of Agriculture and Technology, Vedasandur.

Introduction

Guava are tropical fruits with yellowish-green skin and is a nutritious and healthful food that is rich in several important nutrients. The fleshy fruit of the guava plant and the leaves are edible, with the fruit most often eaten as a snack and the leaves commonly boiled into an herbal tea. There are around 150 species of guava that can be found in tropical and sub-tropical areas around the world. Farmers cultivating guava as a source of food (fruit) and in decorative purposes. The guava (*Psidium guajava)* is a phytotherapic plant used in folk medicine that is believed to have active components that help to treat and manage various diseases. The many parts of the plant have been used in traditional medicine to manage conditions like malaria, gastroenteritis, vomiting, diarrhea, dysentery, wounds, ulcers, toothache, coughs, sore throat, inflamed gums, and a number of other conditions. This plant has also been used for the controlling of life-changing conditions such as diabetes, hypertension, and obesity. The fruit is replete with antioxidants and other nutrients like vitamin C and lycopene. It is a powerhouse of fiber. Guava may help manage diabetes, protect the heart, and boost digestive health. Guava is believed to have originated from an area extending from southern Mexico into or through Central America.

Distribution

Major guava producing countries including India, South Africa, Jamaica, Egypt, Brazil, Thailand among many others. In India, major guava producing states include Uttar Pradesh, Rajasthan, Karnataka, Gujarat, Uttar Pradesh, Maharashtra, Bihar, Andhra Pradesh and Tamil Nadu. Out of all the states, Maharashtra is the leading producer of Guava both quantity wise as well as area. The Spaniards and Portuguese are considered to be responsible for distribution of guava fruit to other parts of the world. While humans have played a large role in its travels, birds and animals have also carried guava seeds. Today, guavas are grown in Florida, Hawaii, and southern California.

India is the number one guava producing country in the world. Although guava can be grown throughout India, it is most successful in Uttar Pradesh, Punjab, and Haryana. Approximately 501,600 acres are dedicated to guava production in this country.

Guava Juice

1. It is a topical fruit that belongs to the myrtle family
2. Around 150 varieties of Guavas include apple Guava, cherry Guava, strawberry Guava and red apple Guava can be found in tropical and sub-tropical regions across the globe
3. Guavas contain around 100 to 500 miniature seeds inside them that are of edible quality
4. Some varieties of Guava have been found to be seedless
5. It can be eaten raw, as a juice, in the form of jellies or in a salad.

Benefits of Guava Juice

Guava is considered an amazing fruit because it has time-and-again proved to have positive effects on the body. Right from improving immunity to providing instant energy to a worn out and tired body along with maintaining blood pressure & weight loss, this fruit does it all with great effects.

'Pink guava' a fruit that offers so much greatness at such an insignificant price. Rich in Vitamin C and loaded with dietary fiber, this pink angel helps us make innumerable culinary creations – right from beverages, candies, dried snacks, fruit bars, desserts to an alcoholic beverage called 'Pulque De Guava'.

Pink Guavas are your perfect refreshment on a boring day. You can also check out the various mocktail recipes you can make with Real Fruit Power.

Some Varieties are as Follows

1. L-49 (Lucknow-49).
2. Allahabad Safeda.
3. Banarasi.
4. Chittidar.
5. Harijha.
6. Red Fleshed.
7. Arka Mridula.
8. Guava Live Plant (Seedless Guava).

100 Grams (G) of Raw Guava Fruit Contain

1. 168 calories.
2. 14.32 g of carbohydrates.
3. 8.92 g of sugars.
4. 0.95 g of fat.
5. 5.4 g of dietary fiber.
6. 417 mg of potassium.
7. 228.3 mg of vitamin C.
8. 624 international units of vitamin A.

Guava-Nutritional Facts

It is known to be a superfood for no reasons. It is a fruit that is rich in:

1. Vitamin A, C & E
2. Lycopene
3. Antioxidants
4. Manganese
5. Folate
6. Potassium
7. Phosphorous
8. Phytochemicals.
9. Magnesium.
10. Dietary fiber.

Some Health Benefits are as Follows

1. Antioxidant Property
2. Prevents Constipation
3. Heart Healthy
4. Treats Cough and Cold
5. Betters Digestion
6. Enhances Oral Care
7. Improves Blood Circulation
8. Good for Diabetics
9. Good for Eye Health
10. Boosts the Immune System.
11. Anti-ageing Properties.
12. Enhances the Skin.
13. Guava Juice during Pregnancy.

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Indian Laurel Trees

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Angel.Y[1], A. Vignesh Kumar[2]

[1]Assistant Professor, Deptt. of Horticulture, Kalasalingam School of Agriculture and Horticulture, Kalasalingam Academy of Research and Education, Krishnankoil, Virudhunagar-626 126, Tamil Nadu.
[2]Assistant Professor, Deptt. of Horticulture, S. Thangapazham Agricultural College, Vasudevanallur, Tenkasi-627 758, Tamil Nadu.

Botanical Name

Terminalia elliptica.

Family

Combretaceae.

Common Names

Crocodile Bark Tree, Indian Laurel, Silver Grey Wood, White Chuglam (English); Asan, Saj (Hindi); Banappu, Karimathi, Mathi, Sadada, Unapu Mara (Kannada); Sahaju (Odiya); Karu-Maruthu (Tamil); Inu Maddi, Nalla Maddi (Telugu).

Etymology

The generic name, Terminalia is derived from the Latin word, terminus terminus meaning boundary, which denotes the arrangement of leaves at the end of twigs; the specific epithet, elliptica denotes its elliptic-shaped leaves.

Description

Deciduous tree with Description spreading branches and heavy crown, growing up to 32 m tall; bark with deep longitudinal fissures and transverse cracks, grey-black. Leaves elliptic to ovate with 1 or 2 glands at lamina and petiole junction. Flowers in panicles, terminal and auxiliary, small, dull yellow. Fruits a drupe with 5 broad wings, up to 5 cm long.

Flowering

February – May.

Fruiting

June – October.

Distribution

India, Nepal, Bangladesh, Myanmar, Thailand, Laos, Cambodia and Vietnam. It is common in the tropical moist deciduous forests and tropical dry deciduous forests, especially in the humid regions of India including the sub-Himalayan tracts of North-west provinces, and also southwards throughout the Peninsular India. It is common associate of sal and teak in their respective zones.

Traditional Use

Water stored in the stem is often used for drinking purpose by the forest folk.

Medicinal Uses

The plant is known to possess many Medicinal Uses medicinall properties like antifungal, antioxidant, anti-hyperglycaemic, antidiarrhoel and antileucorrheal.

Conservation

Conservation As this species is threatened by over-exploitation and habitat degradation, conservation measures are to be augmented.

Propagation

The plant reproduces through natural r Propagation regeneration. The species can be best raised by direct sowing and by planting root and shoot cuttings.


Reference

Botanical Survey of India, Western Regional Centre, Pune.

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Concept of Gene Regulation

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Aswini Nunavath[1]
[1]Ph.D Scholar, Department of Genetics and Plant Breeding, Professor Jayashankar Telangana State Agricultural University, Hyderabad-500030, Telangana, India.

A gene is a small piece of genetic material written in a code and called DNA. Each gene has set of instructions with in it for making molecules that organisms need to survive. Genes themselves cannot be used by an organism. Instead, they must be turned into a gene product. Gene expression is the process by which the information contained within a gene becomes a useful product.

Is there Any Main Principle Behind the Gene Expression?

Yes, there is a principle which clearly describes the main principle behind the gene expression i.e., the central dogma of molecular biology given by Crick (1958), an explanation of the flow of genetic information within a biological system. It describes the process by which the information in genes flows into proteins: DNA → RNA → protein. DNA contains genes that code for proteins. RNA is the intermediate between DNA and proteins. It carries information in genes from the nucleus to the cytoplasm in eukaryotes. Proteins are the determinants of the structure and the function of a particular cell.

Gene Expression is Highly Regulated in Order to Adjust the Cell's Enzymatic Machinery and Structural Components to Changes in the Nutritional and Physical Environment

Before going into the regulation, one should know about the types of genes.
1. Constitutive Genes, are the genes whose expression is not regulated and shows continuous expression. **Ex:** Enzymes of citric acid cycle
2. Inducible Genes, expressed only when a specific positive regulatory substance, i.e. an inducer or activator is present. **Ex:** Production of the enzyme galactosidase is induced by the presence of lactose in prokaryotes.

Regulation of Gene Expression

Genes can be expressed as either RNA or protein. However, not every gene product is needed all the time, nor are they needed in the same amounts. In fact, it would be very energetically demanding for a cell to express every gene all the time. Further, some gene products are harmful to the cell and thus only expressed at the end of a cell's life. Because of these reasons, we regulate the expression of our genes.

How do We Know What Gene Product is Needed, when it is Needed, and How Much is Needed?

Our cells actually have a very complicated system of mechanisms to monitor themselves and their environment. They take internal and external signals, analyse them, and then decide if a gene product is needed. Once it is decided that a gene product is needed, cells have a process to create a gene product.
Gene regulation occurs at various levels viz., gene amplification/replication, regulation of transcription, post-transcriptional regulation, translational regulation and post-translational regulation. Among these levels, **regulation of transcription is universal.**

1890: Yeast cells cultured in medium containing lactose began lactose fermentation immediately. In contrast yeast cells cultured on medium without containing lactose could begin lactose fermentation in 14-16hrs. It was discovered that enzymes concerned with lactose metabolism produced in presence of lactose only. It clearly describes the process of induction.

1959: Pardee *et al.*, concluded that a repressor that prevents the production of enzymes involved in lactose metabolism. It clearly describes the process of repression.

These findings paved the path to know the universally accepted operon concept of gene regulation.

Types of Regulation of Gene

Positive Regulation: When the expression of genetic information is increased by the presence of specific regulatory element is known as positive regulation and element modulating positive regulation is known as positive regulator. When transcription of a gene is activated, both the mRNA and encoded protein or proteins are produced at much higher rates.

Negative Regulation: When the expression of genetic information is diminished by the presence of specific regulatory element is known as negative regulation and element modulating negative regulation is known as negative regulator. When transcription of a gene is repressed, the corresponding mRNA and encoded protein(s) are synthesized at low rates.

Regulation in Prokaryotes

In Prokaryotes, genes are organized in groups called OPERONS.

OPERON

A group of structural genes whose transcription is regulated by the same set of genes viz. regulator genes, promoter and operator sequences.

The Operon Model Proposes Three Elements

A set of structural genes (i.e., genes encoding the proteins to be regulated). An operator site, which is a DNA sequence that regulates transcription of the structural genes. A regulator gene which encodes a protein that recognizes the operator sequence.

1. Positive – inducible
2. Positive – repressible
3. Negative – inducible
4. Negative – repressible

Regulation in Eukaryotes

Eukaryotic gene expression is more complex than prokaryotic gene expression because of thousands of genes constitutes the genome of multicellular eukaryotes and expressed in a controlled fashion.

Spatial gene expression: Not every gene product needed in every tissue. Some genes expressed in nerve cells, some in blood cells and some other in reproductive cells. Complexity of multicellular eukaryotes partly due to the tissue specific expression of many different genes.

Ex: Tubulin genes in plants.

Tubulin polypeptides forms the building blocks of microtubules. α tubulin and β tubulin forms a dimer (α β) and assembled in parallel rows to form hollow cylindrical microtubules about 24 nm in diameter. Several microtubules aggregate with each other to create more complex structures namely cilia and flagella. These α and β tubulins are encoded by distinct set of genes.

Ex: *A. thaliana* has 6 α tubulin genes and 9 β tubulin genes are expressed in a specific spatial pattern (Cheng *et al.,* 2001). TUA1 gene has α tubulin expressed in pollen grains but not expressed in leaves, stems or roots. TUB2 gene constitutes β tubulin, which expressed in roots. TUB8 gene has β tubulin that is expressed in vascular tissues. It suggests that slightly different types of microtubules are needed in different parts of Arabidopsis plants.

Temporal gene expression: Different genes are expressed at different times. Some in response to biological signals such as hormones and some in response to environmental stimuli. When a fertilized egg grows into a multicellular organism, groups of genes are expressed in an orderly sequence viz. sequential modification of tissues and organs leads to the formation of complete organism

Ex: Globin genes.

One of the most dramatic examples of temporally regulated gene expression is the study of haemoglobin. It is a tetramer of polypeptides called globins consists of two different polypeptides viz. $\alpha 2\beta 2$ and contains molecules of iron containing compound called haeme. This molecule is loosely joined to each of these polypeptides and pockets that can bind molecular oxygen. In humans, multiple genes for α and β globins

(Talbot *et al.,* 1989) are located in two separate sites in genome i.e., α globin genes on chromosome 16 (28kb) and β globin genes on chromosome 11 (45kb). These genes are duplicates of an ancestral globin gene and formed a multigenic family but during evolution members of these gene families diverged from each other because of mutation and encodes a slightly different polypeptide.

Importance of Gene Regulation

1. To control the amount of gene product present in the cell.
2. To allow cells to adjust with changing conditions.
3. Specialization and division of labour among cells.
4. Expression of appropriate genes at proper time.
5. Synchronized regulation of multiple genes encoding products with interdependent activities.
6. Prevent the wastage of cellular energy and thus safeguarding a cell.

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