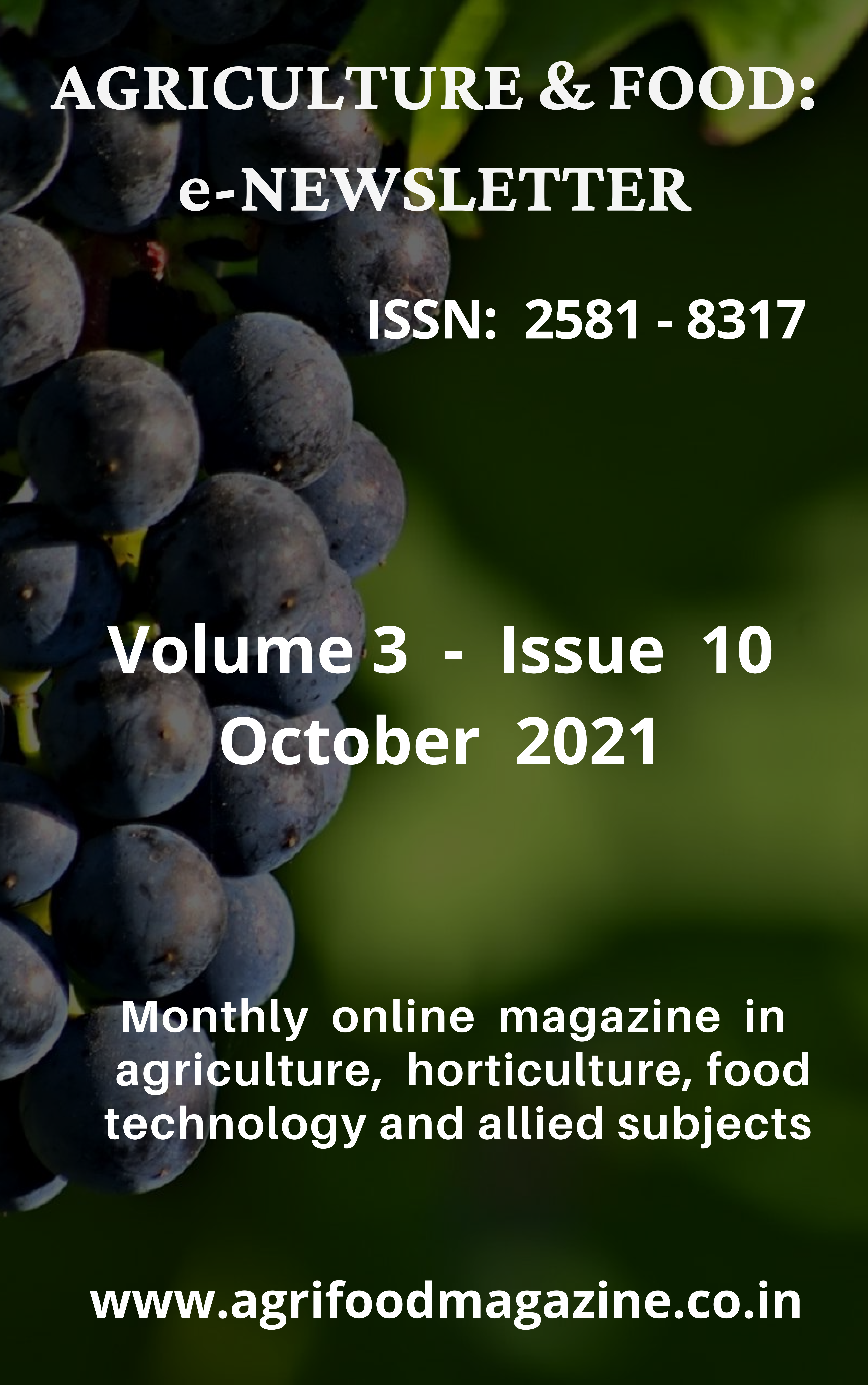

AGRICULTURE & FOOD: e-NEWSLETTER

ISSN: 2581 - 8317

Volume 3 - Issue 10
October 2021

Monthly online magazine in agriculture, horticulture, food technology and allied subjects

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AGRICULTURE & FOOD: e-Newsletter Volume 3 – Issue 10 – October 2021
www.agrifoodmagazine.co.in
e-ISSN: 2581-8317

Highlights of Research and Innovation in DPRK Agriculture in 2020-2021

Invited article id: INV4526

Bir C. Mandal
Dy. FAOR- DPR Korea, Pyongyang

Varietal improvement

- In 2020, the Academy of Agricultural Sciences (AAS), as stated by vice-president of the Academy Kim Sang Hyok, has registered as state species 67 varieties of 28 crops including rice, maize, red pepper, tomato, peach and grape. They are listed as national agrotypes. The new varieties are high-yielding, and have strong resistance to unfavourable climatic conditions such as high temperature, drought, rainy season and cold weather and to harmful insects.
- The Maize Research institute has developed an extremely early variety which has a growing period of less than 130 days and is resistant to diseases, moisture damage and drought, and another variety which yields higher in the intermediate areas along the western coast of the country and is highly resistant to low temperature and moisture damage.
- The Rice Research Institute of the Academy of Agricultural Science has recently developed new rice varieties, which can produce higher yields in low-yielding soils (problem soils, marginal growing environment). These include varieties highly resistant to salt and suitable for tidelands and also a hybrid variety (F1) with two to three times higher yielding capability than conventional varieties in salt-affected soils. [1]
- A new potato variety has been developed that can yield about 40 tonnes per hectare as the main crop in the alpine regions with altitudes more than 800 metres above sea level.
- The Pyongyang Vegetable Science Institute has recently developedten species of high-yielding vegetables which are being disseminated to cooperative farms in the country. These include varieties of tasty cucumber, tomato, hot pepper and carrot with high nutritive value and productivity. They are gaining popularity with vegetable producers.[2]
- The Pomology institute registered as state species nine varieties of peach, two of pear and apple and four of grape and date, including a plum peach which has an average weight of 135.7g, sugar content of 15 percent, acid content of 0.45 percent and average yield of over 10 tonnes/ha.
- A new variety of watermelon with high-yielding potential and resistance to low temperature and soil moisture has been developed which is gaining popularity with greenhouse producers. Besides, 19 new fruit varieties like Sukchon apple are expected to be widely introduced into fruit farms.[3]

Crop management

[1]Research into new rice varieties in full swing, Pyongyang Times, 10 April 2021

[2]Modern vegetable research and production base, Pyongyang Times, 10 July 2020

[3]Over 60 crop varieties registered as national species,(Pyongyang Times, 1 July 2020

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- The Agricultural Information Institute under the Academy of Agricultural Science has completed the field digital map and introduced it into the agricultural sector of the country.The map contains databases of all arable lands in the country according to classification of fields and land categories. It supports the data of soil and weather conditions and forecast on a real-time basis. The map allows cooperative farms to rationally distribute crops according to fields and estimate the growth and yield of crops. [4]

Scientific farming

The following is a list of approaches and methods applied in DPRK's cooperative farms under the broad concept of scientific farming[5].

- Use of high-yielding crop varieties suitable for local climatic conditions
- Constantly upgrade crop management practices based on adaptive research, such as growing of rice seedlings, rice transplantation, manuring and other cultivation processes
- Expand double cropping to suit local specific conditions
- Improve soil fertility by application of organic as well as mineral fertilizers
- Increase efficiency of on-farm water management by improving delivery of irrigation water through irrigation channels across crop fields. Cooperative farms in many instances consider it as a right strategy for introducing double cropping and increasing crop yields.
- Selective mechanization of farming operations by increasing use of locally fabricated farm machines and tools such as rice seedling transplanter, tall seedling transplanter, tall seedling seeding machine, wheat and barley sowing machine and thresher
- Expansion of the System of Rice Intensification (SRI) adapted to DPRK's cooperative farming –use of selected rice varieties and seedlings suitable for location-specific agro-climatic conditions; enhancing soil fertility using organic fertilizers such as Sinyang-2 fermented compost; properly fixing the period for transplanting paddy seedlings; optimum leaf age; number of hills per unit area; and number of seedlings per hill.

INNOVATION

Organic fertilizer developed

(Pyongyang Times, 22 February 2021)

A research group of Kim Il Sung University has developed Earthworm compost and nutritive solution. The compost represents biological humus produced by earthworms after digesting large amounts of organic wastes. According to the lead researcher, the earthworm compost promotes the growth of plants 1.5-2 times faster than do ordinary compost and 1.3-1.4 times faster than chemical fertilizer.

The research results showed that earthworm digests any organic materials except metal, glass, and rubber and decomposes them into substances that do not cause harm to people before excretion.

[4] To Put Agricultural Production on Scientific and IT Footing, KCNA, 22 August 2020

[5] Scientific farming methods widely applied, Pyongyang Times, 11 November 2020

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The research group has selected a strain of earthworm with high productivity of compost after evaluating a large number of native earthworm species and widely bred it to establish large-scale production of quality earthworm compost and nutritive solution based on it.

In 2020, the earthworm nutritive solution was sprayed in a trial on vegetable crops grown in the Sosamjong Vegetable Cooperative Farm in Ryokpho District, Pyongyang, which was hit by flood and typhoon. The farm harvested two times more vegetables than the previous year in the field where yield was expected to be poor.

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Best Practice: DPR Korea

Invited article id: INV4527
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Dy. FAOR- DPR Korea, Pyongyang

1. Descriptive title: Large scale adoption of maize transplanting in DPR Korea

2. When was the practice initiated (and competed, if applicable)? [date]:
Maize transplanting was initiated at the end of 1960s. Since 1975 the practice was adopted by all maize growers as a routine and common practice for maize cultivation in DPR Korea.

3. Brief description of the practice
In DPR Korea, harsh cold continental climate places severe limitation on maize production besides limited availability of cultivable land in a predominantly mountainous country. Until late 1960s, maize cultivation was limited to southern provinces where the climate was favourable for maize cropping. National production of maize was insufficient due to restricted growing area, single cropping throughout the year and low yields.

Dissemination of maize transplanting as a standard agronomic practice aimed at increasing maize production to meet national food demand. The practice comprises several steps: a) preparation of humus cakes for raising seedlings; b) sowing seeds in humus cakes; c) growing seedlings in protected seedbeds; and d) transplanting seedlings in furrows in prepared crop fields.

Seedlings cultivated under protected seedbeds are normally transplanted at 2 - 3 leaf stage but transplanting at 4-leaf stage is more common practice among farmers in northern hilly areas where cropping season is shorter and farmersgrow two crops, maize as first crop and autumn vegetable as second crop.

4. Achievements/accomplishments
Adoption of the practice contributed to increasing maize yield and farmers' income. It helped extend maize cultivation area to northern provinces with short growing period for maize by allowing raising of seedlings in protected seedbeds when the temperature is still low for field planting. It also enabled farmers to introduce double or even triple cropping in southern provinces where vegetable or cereal crops can be cultivated both in spring (when maize crop is still in seedbeds) and in autumn (when maize crop is already harvested) generating additional income from increased total production.
Adoption of the approach benefitted farmers with decreased unit production cost for maize crop. It decreased seed consumption to the half of that in direct seeding while improving germination and rooting rate and decreasing labour for additional planting (replanting for blanks).It needs less weeding inputs in

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comparison with direct seeding and improves efficiency of fertilizer application decreasing fertilizer consumption for unit production, significantly decreasing threats and burden on environment. It also enables farmers to minimize crop damage and loss from climatic hazards through precise timing of field cultivation aided by seedling cultivation on protected seedbeds.

5. Necessary conditions

Seedbed should be prepared at the plot where the wind can be avoided and exposure to sunlight is sufficient. Seedbed soil should be rich in humus to provide adequate nutrition. Transplanting is a labour-intensive practice and requires mechanization.

6. How was this practice carried out?

The maize seedling cakes are prepared by farmers using simple manual tools by mixing humus and soil with chemical fertilizers and compost. One germinated seed is dropped into each cake. The seedbeds are immediately irrigated after seeding. The temperature and humidity of soil in seedbeds should be observed and regulated. The seedbeds are covered with plastic films for major protection and the films are covered with straw mats for additional protection. Temperature and carbon dioxide concentration inside the protection should be regulated by cyclic uncovering and covering.

7. Replicability and/ or upscaling:

Maize transplanting can be applied to all maize growing fields. Maize transplanting is, indeed, common in DPRK and it is successful. However, this practice needs more workers particularly to grow seedlings under protected environment. This practice can be adopted in other countries where temperature is cold and family members could also support to grow seedlings under protected environment.

8. Additional information

MANDAL, BIR C., 2014, MAIZE BREEDING AND SEED PRODUCTION MANUAL

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E-ISSN: 2581 - 8317

Transforming the Rural Youth to Agriculture Extension Service Providers

Article ID: 12000

P. Sadvi, R. Uma Reddy, P. Jagan Mohan Rao, D.A. Rajini Devi, N. Navatha

India has 600 million young people and more than half of the population is under 25 years old. But, despite the large numbers of youth, fewer are choosing agriculture as their livelihood activity.

Youth migration from rural to urban areas to find employment has been increasing – to date around 30% of 315 million migrants are youth. Based on a report from the World Bank, by 2050 half of the Indian population will be urban. At the same time, it is estimated that the percentage of agricultural workers in the total workforce will drop from 58.2% in 2001 to 25.7% by 2050. Ageing farmers and a waning interest of rural youth in agriculture is becoming a prime concern in India.

Potential of agriculture is not a constraining factor for the rural youth to take up farming as a vocation. But why they don't reap a good harvest and price are the main reasons.

With this background 25 days Skill development training programme on "Agriculture Extension Service Provider" was organized at Regional Agricultural research station, Polasa, Jagtial for rural unemployed youth (85No.s) from 2018 to 2021. The Service Provider is responsible for speedy transfer of information and technology to farmers. He reduces the time lag between generation of technology and its transfer to the farmers for increasing production, productivity and income from agriculture and allied sectors on a sustained basis.

An agriculture extension service provider gives talks, guidance and actual demonstrations on latest technologies related to agriculture. He also works with other experts in agriculture to learn more or even develop new methods that could advance production. As a part of training class room lectures, exposure visits, field visits and assignments were conducted. Resource persons having good technical expertise were delivered the theme areas. These training methods enable the participants to gain knowledge, skills required for adopting the latest technologies in agriculture.

As a part of the training the participants were taken to successful enterprises i.e. various agro based and allied sector based enterprises , innovative farming units i.e. adoption of integrated farming systems, natural farming and also hands on experience on various agricultural activities i.e. soil testing, preparation of natural farming inputs, preparation of value added products and also making of agricultural information material i.e. leaflets, pamphlets , wall newspapers for providing agricultural information to the farmers.

Participants Providing the Agricultural Extension Services to the Farmers After the Successful Completion of Training

Mr. Sagar trained, Agricultural Diploma holder trained under skill development training programme on "Agriculture extension service provider" started AGROS Rythu Seva Kendram and also besides earning income from sale of seeds and fertilizer, he is also motivating the farmers in application of balanced fertilizer to the crop and also guiding the farmers to form farmer producer organization.

Mr. Rajesh trained under skill development training programme on "Agriculture extension service provider doing as input dealer and he is providing agro advisories besides sale of inputs i.e., seed, pesticide, fertilizers. He also shares success stories of innovative farmers who adopted the low-cost machinery for the cultivation of crops. He also participates in the agricultural programmes and guides other farmers by receiving the suggestions from the officials.

Mr. Ramesh trained under skill development training programme on "Agriculture extension service provider" is cultivating the minikits distributed by the research station and giving the feedback of performance of the minikits and also, he is cultivating the latest varieties released from the university and motivating the fellow farmers about the crop varieties and their advantages.

Mr. Santhosh trained under skill development training programme on "Agriculture extension service provider is preparing the low-cost farm implements i.e., brush cutter with petrol sprayer pump engine, cultivator with bike engine, fertilizer drop in instrument etc. And helping the farmers in cutting down the cost of cultivation in performing various activities in agriculture by the low-cost farm implements.

Ms. Saipriya trained under skill development training programme on "Agriculture extension service provider is serving the farmers by giving agricultural extension services and guiding the farmers for performing the agricultural skill-oriented activities efficiently and also guiding the farmers in adoption of latest cultivation methods in different crops.

Mr. Mahesh trained under skill development training programme on "Agriculture extension service provider is guiding the farmers in taking of soil sample and enlightened the farmers on importance of soil health. He collected the soil samples of the farmers of his village by demonstrating the soil sampling procedure. Thus, he helped the farmers in timely receiving of soil health cards.

Mr. Rajendar trained under skill development training programme on "Agriculture extension service provider is performing the sales of agricultural implements and also creating awareness on uses of various farm machinery in reduction of cost of cultivation. He motivated the farmers on drum seeding, machine transplanting by conducting the demonstrations in the farmer fields. Thus, the input cost and time in performing the agricultural operations for the farmers were reduced.

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E-ISSN: 2581 - 8317

Effect of Botanicals in Plant Disease Management

Article ID: 12001

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Introduction

Botanicals are toxic to pathogens. When extracted from the plant parts and applied on pathogen infected crops, these components are called botanicals. Botanicals have component with phenolic structure and theses groups of components show antimicrobial effect and serves as plant defense mechanisms against pathogenic microorganism (Das *et al* 2010). The volatile antimicrobial substance allicin (diallyl thio sulphinate) is synthesized in garlic. Allicin effectively controlled seed-borne diseases like *Alternaria* spp. in carrot, *Phytophthora* leaf blight of tomato and tuber blight of potato as well as *Magnaporthe* on rice and downy mildew of *Arabidopsis thaliana* (Slusarenko *et al* 2008.) Mostly underground parts of plant (root, tuber, rhizome, bulb etc.) were used extensively compared with other above groung parts in control disease of crops. The use of botanicals for plant disease management is a vital area of research now days. Those botanicals are less hazardous and also less environmental impact. Commonly used botanicals are neem, garlic, onion, tobacco, tulsi, eucalyptus, *Calotropis* sp., clove and Mustard etc.

Why Considers Botanical?

1. Eco-friendly.
2. Easily bio-degradable.
3. Organic farming.
4. Cheaper.
5. Reduce crop losses.
6. Non-hazardous to human.

Commonly Used Some Botanicals

Neem	Azadirachta indica
Garlic	*Allium sativum*
Onion	*Allium cepa*
Tobacco	*Nicotiana tabacum*
Tulsi	*Ocimum sanctum*
Eucalyptus	*Eucalyptus globulus*
Tulsi	*Ocimum tenuiflorum*

List of Botanicals Known to Control Plant Diseases

Plants	Parts used	Form of use	Diseases controlled	Reference
Neem	Leaf	Ash	Seed rot of wheat	Enikuomehin et al. (1998)
	Leaf	Dust	Collar rot of cauliflower	Prasad et al. (2003)
	Leaf	Extract	Rust of groundnut Leaf spot of chili Alternaria leaf spot of mustard	Suresh et al., (1997) Maharishi (1993) Meena et al. (2004)
		Cake	Sheath blight of rice	Prasad et al. (1998)
	Seed	Kernel Extract	Early blight of potato Leaf spot of groundnut Leaf blight of sunflower	Patil et al. (2003) Lokhande et al. (1998) Amaresh et al. (2002)

Garlic	Leaf	Extract	Stem rot of chili Gladiolus wilt	Mathur and Gurjar (2002) Tomar and Chandel (2006)
	Clove	Extract	Late blight of potato Wilt of pea Wilt of chickpea	Singh and Singh (1983) Sinha and Sinha (2004) Srinivasulu et al. (2002)
Onion	Seed	Extract	Early and Late blight of potato	Abd-El-Khair and Wafaa (2007)
Tobacco		Decoction	Early blight of potato	Patil et al. (2003)
Tulsi	Leaf	Extract	Charcoal rot and wilt of cowpea Gladiolus wilt	Ushamalini et al. (1997) Tomar and Chandel (2006)
Eucalyptus	Leaf	Extarct	Early and late blight of potato Leaf blight of wheat	Abd-El-Khair and Wafaa (2007) Patil and Kulkarni (2002)

Limitation of Botanicals for Plant Disease Management

1. Rapid degradation.
2. Less effective.
3. Need for the development of formulations.
4. Extraction method are not standardized.


Neem


Garlic


Onion


Tulsi


Eucalyptus

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Production Technology of Chrysanthemum (Guldaudi) Under Lucknow Region

Article ID: 12002

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The name chrysanthemum (Guldaudi) is derived from the Greek chryos meaning gold and anthemon meaning flower. Early depictions of chrysanthemums show them as small, yellow, daisy-like flowers. *Asteraceae* family was formerly known as the *Compositae* Chrysanthemums have a history that is as colorful as the flowers themselves. First cultivated centuries ago in China, the chrysanthemum was used primarily as a culinary herb.

Varieties

Pusa guldasta, Pusa aditya, Pusa sona, Pusa Centenary, Birbal sahani, Apsara, Nilima, Snow Ball, Chandrama, Sonar Bangla, Little Pink, Little Kusum, etc.

Climate

Tropical and subtropical climatic conditions are ideal. However, the best temperature for growing chrysanthemum is 20-28^{0}C for day and 15-20^{0}C for night. Since chrysanthemum is a short-day plant, planting should be done such that flowering coincides with short day conditions. and Cut chrysanthemums are grown under polyhouse with the following environmental conditions. Temperature 16 - 25^{0}C, Relative humidity 70 - 85 %, CO_2 600 - 900 ppm.

Photoperiod

Long day conditions with 13 hours light & 11 hours darkness during vegetative stage (upto 4-5 weeks from planting) and short-day conditions with 10 hours light & 14 hours darkness during flower bud initiation stage.

Soil

Well drained sandy loam soil with good texture and aeration with pH of 5.5 to 6.5.

Propagation and Planting

Commercial propagation is through terminal cuttings (5-7 cm long) or suckers. Planting during June - July at 30 x 30 cm spacing on one side of ridges (1,11,000 plants/ha).

Irrigation

Irrigation is done twice a week in the first month and subsequently at weekly intervals.

Fertilizer Management

Recommended dose -25t FYM and 125:120: 25 kg NPK/ha. Basal application - half of N + entire P and K; top dressing - half of N applied 30 days after planting.

Growth Regulators

Alar 50 – 150 gm/100 lit water and B 9 at 8 – 25 ml/lit of water is used twice at the growing stage.

Special Practices

Pinching:

First pinching - 3 weeks after planting.
2nd pinching - 5 weeks after planting.

Disbudding: In spray varieties, only the large apical bud is removed and the lateral buds are retained. In standard varieties, the lateral buds are removed and only apical buds are allowed to develop.

Blindness: It occurs when the night temperature is too low and the days are short at the time when flower buds are forming. A rosetted type of growth is indicative of this difficulty. Center petals that fail to develop can be due to excessive heat; or in dark weather some varieties apparently lack enough food to open the flower. Chlorosis, or yellowing of the upper foliage, is generally associated with over watering, excessive fertilizer in the soil, or insects or diseases attacking the root system. Continued growth of shoots and failure to form flower buds when short days are started the mean night temperature was too low. Sunscald is prevalent on standards in flower in very warm weather. The petals turn brown and dry up.

Light requirement: Chrysanthemum is very much influenced by light and hence photoperiod should be regulated. (Photoperiod should be regulated as detailed under climate.

Growth phase	Weeks from planting	Photoperiod
Vegetative phase	Up to 4-5 weeks from planting till the plant attains 50 to 60 cm height.	Long day: 13 hrs light and 11 hrs dark.
Flowering	5 -6 weeks after planting till harvest	Short day: 10 hrs light and 14 hrs dark.

Growth regulators: Spray GA3 (50 ppm) at 30, 45 and 60 days after planting to increase flower stem length.

Weed management: Weeding and hoeing are done manually as and when required.

Plant Protection

Pests:

Leaf miner: Spray Imidachloprid @ 0.5 ml/l.
Aphids: Spray Monocrotophos @ 1 ml/l.
Red spider mite: Spray Propargite @ 2 ml/l.

Diseases:

Powdery mildew: Spray Wettable Sulphur @ 2g/l.
Wilt: Soil drenching with Carbendazim @ 1 g/l.
Leaf spot: Spray Macozeb @ 2g/l or Difenoconazole @ 0.5ml/l.

Harvesting:

Standard types: Flowers are harvested when 2 - 3 rows of rays florets are perpendicular to the flower stalk.

Spray types: When 50% flowers have shown colour for distant markets; when two flowers have opened and others have shown colour for local markets.

Yield:

Standard types: 10-15 flower stems / plant.
Spray types: 100000-120000 flower stems / hec.
Loose flower: 10-15 T / hec.
Greenhouse: 150-250 flower / m^2.

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Beneficial Effect of the Rhizosphere Microbial Population for Plant Growth and Phytopathogenic Activity in Plant

Article ID: 12003

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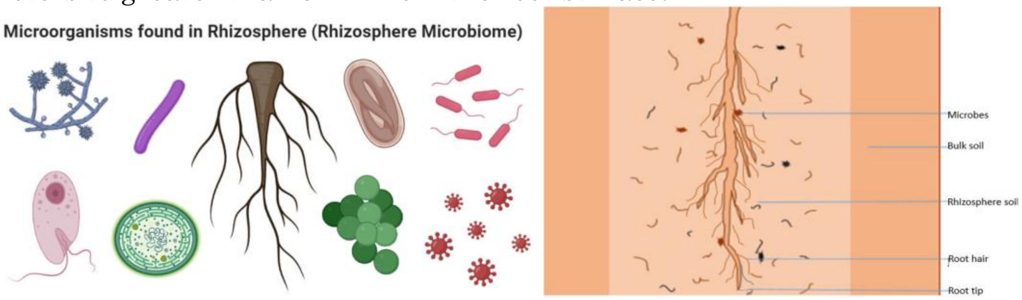
Introduction

Plant rhizosphere microbes present in the soil nearest to the plant root surface which roots release high number of metabolites from living root hairs or fibrous root systems an "epicenter" of bacterial concentrations. The rhizosphere is a narrow zone of soil surrounding and influenced by the root of vascular plants. This zone is characterized by intense biological activity owing to the release of root exudates, which stimulate or inhibit rhizosphere organisms. These interactions range from symbiotic relationships such as N2 fixation and mycorrhizal associations to pathogenic interactions. Management strategies such as bioremediation and biological control may be successful when rhizosphere ecology is considered. A greater understanding of the rhizosphere and its effects on organisms that inhabit this area will allow for manipulations that benefit plant production and the environment. This zone of soil ranges from only a few hundred micrometers to greater than 5mm from the root surface.

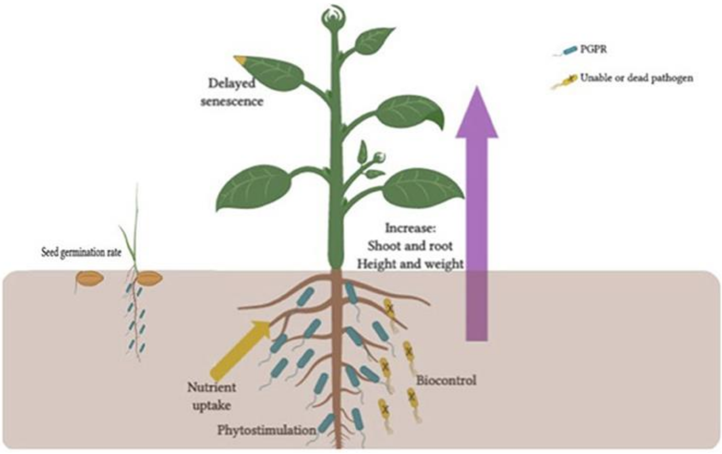


The Rhizosphere Effect

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. The rhizosphere is thus the zone of soil influenced by roots through the release of substrates that affect microbial activity. The rhizoplane is the root surface, including the strongly adhering root particles. The root itself is a part of the system, because certain endophytic microorganisms are able to colonize inner root tissues Oluwadara *et al.* (2021). Two types of food chain occur in the rhizosphere, the first being detritus based (dead plant matter), which fuels either the bacterial or fungal carbon channel, depending on the labile or recalcitrant resources, respectively.

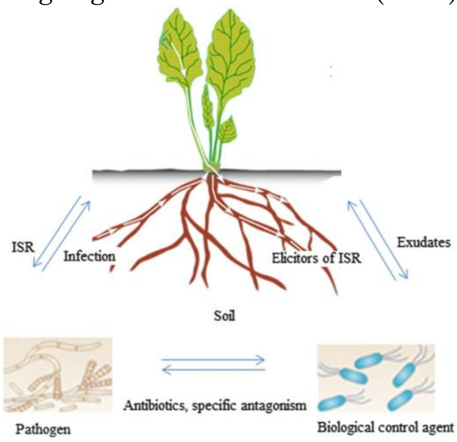
Plant Growth Promotion

Phytopathogenic microorganisms are a major threat to sustainable agriculture. The plant pathogens eat up soil fertility, disturb soil ecology, damage groundwater quality, and directly persuade crop yield. Bacteria constituting rhizomicrobiome contribute to soil fertility and promote plant growth indirectly by suppressing the phytopathogens Kumar *et al.* (2017). Phytostimulation may directly enhance plant growth. In the processes of plant growth, induced phytohormones (e.g., production of indole-3-acetic acid, auxins, cytokinins, and gibberellins) play an important role. Indole-3-acetic acid is a phytohormone which is known into be involved in root initiation, cell division, and cell enlargement Nihorimbere *et al.* (2011). This hormone is very commonly produced by PGPRs. plant-associated bacteria can influence the hormonal balance of the plant. Ethylene is an important example to show that the balance is most important for the effect of hormones: at low levels, it can promote plant growth in several plant species.



Phytopathogenic Activity in Plant

Bacteria and fungi live around roots and feed on root exudates and dead root cells. Competition between microbial species in this area is stiff. In the battle for establishment and persistence in the niche, bacteria use several strategies. Root colonization not only results in high PGPR population densities on the root system, it also functions as the delivery system of antagonistic metabolites that are involved in direct inhibition of plant pathogens. the inhibition of microbial growth by diffusible antibiotics and volatile organic compounds, toxins, and biosurfactants, and parasitism that may involve production of extracellular cell wall-degrading enzymes such as chitinases and β-1,3- glucanase. Excretion of chitinases and glucanases by species of Trichoderma and Streptomyces has also been shown to play an important role in mycoparasitism of phytopathogenic fungi. Competition for resources such as nutrients and oxygen occur generally in soil between soil-inhabiting organisms Babin *et al.* (2018).



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Boosting Your Immune System Against Coronavirus: How to Minimize the Risk of Infection?

Article ID: 12004

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Covid – 19 or Coronavirus was declared as a global pandemic by the World Health Organization. And while the countries are grappling with imminent dangers that this virus poses to humanity, there are few key measures that individuals can take to fight this pandemic.

While it is crucial to mention hygiene standards like washing your hands frequently, especially if you have travelled by public transport. Using an alcohol sanitizer, in case you are travelling to disinfect your hands, wearing a mask (cover your nose and mouth) and avoiding touching your hand or mouth. There are also certain methods to improve your immunity which is paramount at this juncture.

Individuals in certain pre-existing illnesses like diabetes, hypertension, cardio vascular disease, and respiratory issues are at a higher risk of having Covid 19 complications, it also aggravates with age as the general immunity reduces as you get older. In the younger generation with no underlying illnesses, Covid 19 can result in a minor infection, provided you have a robust immunity and do not engage in activities like smoking or vaping to combat the onslaught of the virus. Here is a list of measures you can undertake to improve your immunity.

Improve Your Diet

The food you eat plays a key aspect in determining your overall health and immunity. Eat low carb diets, as this will help control high blood sugar and pressure. A low carb diet will help slow down diabetes and focus on a protein-rich diet to keep you in good shape. And regularly consume vegetables and fruits rich in Beta carotene, Ascorbic acid & other essential vitamins. Certain foods like mushrooms, tomato, bell pepper and green vegetables like broccoli, spinach are also good options to build resilience in the body against infections.

You can also eat supplements rich in omega 3 & 6 fatty acids for your daily dose, if stepping out to buy groceries is not an option during social distancing. Some natural immunity supplements include ginger, gooseberries (amla) and turmeric. Some of these superfoods are common ingredients in Indian dishes and snacks. There are several herbs that help in boosting immunity like garlic, Basel leaves and Black cumin. Certain seeds and nuts like sunflower seeds, Flax seed, pumpkin seeds and melon seeds are excellent sources of protein and vitamin E.

Probiotics like Yoghurt, Yakult and fermented food are also excellent sources to rejuvenate the composition of gut bacteria, which is important for nutrient absorption by the body. These are good options for the older generation too.

Don’t Compromise on Sleep

Good snooze time for 7-8 hours is the best way to help your body build immunity; lesser sleep will leave you tired and impair your brain activity. The lack of sleep will prevent the body from resting and this will impair other bodily functions that will have a direct impact on your immunity. Lack of sleep adversely affects the action of the flu vaccine.

Stay Hydrated

Drink up to 8-10 glasses of water every day, to stay hydrated. Hydration will help flush out the toxins from the body and lower the chances of flu. Other alternatives include juices made of citrus fruits and coconut water, to beat the heat.

Don't Skip on Exercise

A good diet should be followed by an exercise routine. Remember to exercise regularly; even light exercise will go a long way in releasing the toxins from your body. It is recommended to exercise for 30 to 45 minutes, depending on your stamina. If you have not started exercising yet, then it is a good time to start. There are several YouTube channels and apps to help you exercise at home. Regular exercise improves metabolism, which has a direct correlation with body immunity.

Destress Yourself

These are testing times, and a prolonged period of staying indoors has its implications on your mental wellbeing. The growing anxiety around the pandemic is another concern that is affecting millions across the globe. While the uncertainty might be overwhelming, there are few steps we can follow regularly to help relieve our stress, stress is known to have an adverse effect on immunity.

1. Practice meditation: Too much stress releases the hormone known as cortisol, which impairs your response to immediate surroundings and makes your body susceptible to infections; you are left feeling constantly anxious. The best way to relieve stress is through meditation, it is a tried and tested activity to calm the nerves. If you need help meditating, then there are several channels on youtube that have instructional resources to help you meditate.

2. Avoid Smoking, alcohol and other addictive substances: Certain habits like smoking, vaping, alcohol consumption and substance abuse have a direct correlation between weakened body defences and respiratory illnesses. Engaging in smoking and vaping is proven to weaken your lung capacity and destroy the cells lining your respiratory tracts, these cells are crucial to fight viruses that enter through your nasal orifices. There is new research claiming that individuals who engage in heavy alcohol consumption tend to suffer from ARDS (Acute Respiratory Distress Syndrome) which is one of the conditions caused by Covid 19 infection. Practice moderation, if you are dependent on any of these, as sudden withdrawal can also prove to be risky.

3. Travelling: Avoid all kinds of non-essential travels. Most Covid 19 positive cases are imported cases, which later spread to the communities. Avoid being exposed to the public transport system and public places to avoid any likelihood of exposure. In case you have to travel, make sure to cover your nose and mouth with a mask and carry an alcohol-based hand sanitizer, at all times. Remember to sanitize each time you touch a surface, as Covid 19 strain can stay on surfaces for a few hours to days. Use your non-dominant hand while accessing the doorknobs and handles, as these are frequently touched by many people.

Supplements and Immunity Boosting Foods

While all the above-mentioned tips will definitely help, the need of the hour is a quick boost to your immunity system to keep it fighting fit. If you're concerned whether you are getting the right amount of nutrients from your diet, consult with your doctor about a supplementation regimen to boost your immune system. Here are a few common supplements and superfoods that can help.

1. Vitamin C: This particular vitamin is a crucial participant in the army of immunity. It helps prevent the common cold. It acts as a powerful antioxidant and protects against damage induced by oxidative stress. For severe infections, including sepsis and acute respiratory distress syndrome (ARDS), high dose intravenous vitamin C treatment has been shown to significantly improve symptoms in patients.

2. Vitamin D: Vitamin D supplements have a mild protective effect against respiratory tract infections. Most people are deficient in Vitamin-D, so it's best to consult with a doctor about taking a Vitamin D supplement to boost immune response.

3. Zinc: Zinc is a vital component to WBC (white blood corpuscles) which fights infections. Zinc deficiency often makes one more susceptible to flu, cold and other viral infections. It is advisable to take a zinc supplement, especially for older people.

4. Elderberry: Elderberries are full of nutrients including minerals like phosphorus, potassium, iron, copper and vitamins, such as vitamin A, B, and C, proteins and dietary fibre. Elderberries have antibacterial and antiviral qualities which help fight cold and influenza.

5. Turmeric and Garlic: The bright yellow spice, Turmeric, contains a compound called curcumin, which boosts the immune function. Garlic has powerful anti-inflammatory and antiviral properties which enhances body immunity.

Apart from maintaining a healthy lifestyle and taking supplements, the Indian health ministry is also suggesting few organic and natural ways to practise as preventive measures to fight COVID-19. The Ministry of AYUSH has recommended the following self-care guidelines as preventive measures and to boost immunity with special reference to respiratory health.

a. Drink warm water throughout the day.
b. Practice Meditation, Yogasana, and Pranayama.
c. Increase the intake of Turmeric, Cumin, Coriander and garlic.
d. Drink herbal tea or decoction of Holy basil, Cinnamon, Black pepper, Dry Ginger and Raisin.
e. Avoid sugar and replace it with jaggery if needed.
f. Apply Ghee (clarified butter), Sesame oil, or Coconut oil in both the nostrils to keep the nostrils clean.
g. Inhale steam with Mint leaves and Caraway seeds.

While the battle against the Covid-19 pandemic is fought by our health care workers, we can do our bit by limiting our exposure to the virus by staying indoors, social distancing, eating healthy, hydrating and following basic hygiene protocol.

Therapeutic and Nutritional Value (i-value) of Acid Lime

Article ID: 12005

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Introduction

More is the popularity of limes than lemons in India. Acid lime is generally grown under both tropical and subtropical climatic condition. The scientific classification of acid lime is from Kingdom: Plantae, Order: Sapindales, Family: Rutaceae, Genus: *Citrus* and Species: *aurantifolia*; the chromosome number being 2n=2X=18. Acid lime trees are small, bushy with small but sharp spines on stem. Leaves are small with short winged petioles. Flowers and fruits are small. Flowers are borne on two types of shoots *viz.*, one with leaves and the other without leaves. Leafy inflorescences are borne on new woods, while leafless inflorescences are borne on old woods. Leafy inflorescence is more productive than leafless inflorescence, thus the presence of leaves is very much essential for production. Staminate and hermaphrodite flowers are produced on the same tree with different intensities. Kagzi lime gives more hermaphrodite flowers than Tahiti Lime. The percentage of perfect flowers is higher because of mild season in the beginning of flowering and gradually falls as the season advances. Fruits are round to oval. Maturity of fruits is irregular throughout the year, greenish-yellow in colour and juice is very acidic. Seeds are small, smooth and cotyledons are whitish. [Taiwo TA. (2005)].

A good acid lime plant of 7–10-year-old may yield 200-1000 fruits annually. The average yield being 500 to 1,000 fruits/tree. [FAO (2006)]. Harvesting of lime and lemons differs with different species, verities and regions of cultivation. The best season of harvesting is from March to April and lean season is from May to June in Maharashtra. The storage life of the fruit is in between 6 to 8 weeks at a temperature range from 9 to100^{0}C and 85 to 90 % relative humidity. The improved varieties are Pramalini, Vikram, Chakradhar, PKM1, Seedless lime and Tahiti lime.

Acid lime adapts well to a wide range of soil. It grows very well in black and light loamy soil. A loamy soil with uniform texture and a depth of 2-2.5m, well-drained, fertile and rich in organic matter is ideal for lime. A well- drained soil with a pH range of 6.5-7.0 is ideal for better growth and yield of the crop.

Acid lime is an important medicinal and food plant variedly cultivated in many parts of the world. It is highly valued for its nutritional properties and numerous health benefits. The plant is used in as a traditional medicine as an antiseptic, antiviral, antifungal, astringent, diuretic, mosquito bite repellent, for the treatment of stomach ailments, constipation, headache, arthritis, colds, coughs, sore throats and used as appetite regulator. These health benefits of the crop are associated with its high amounts of photochemical and bioactive compounds *viz*., flavonoids, limonoids, phenols, carotenoids, minerals and vitamins. So, let's have a detailed study about the overall i-value of the same!

Domestic Value of *Citrus aurantifolia*

The lime fruits are consumed worldwide in form of fresh fruit or are processed into different products and by-products. Roughly, one third of total citrus production is utilized for processing. The fruit juice is used as flavorings in beverages; and it is also used by different companies to produce fruit juice which are presented in the form of freshly squeezed lime juice or frozen concentrated lime juice. The juice prepared is being squeezed from fresh fruit and packaged in paper cartons, glass or plastic containers, without being pasteurized. In addition, the lime fruits can be processed to obtain other food products such as dehydrated citrus products or marmalades, jams, sorbet, pickles, jellies, candies and sugar-boiled.

C. aurantifolia fruit peels are being found very useful domestically. In the kitchen, it is variedly used for many purposes such as cooking, to add flavour to food, cakes and roasted chicken. It is used to garnish salads and to make lemonades. It is used for bathing and washing of hair, and also, used as a deodrant to freshen up smelly garbage and composite pile. It also serves as natural room freshener. It has been found useful as to repel mosquitoes from the body, moth from cloth and cats from gardens. Citrus fruit peels are being transformed into volatile gases through a high-powered microwave. The gasses are then distilled into liquid which is used for making plastics. The fruit peel pulp is used as cereal alternative for ruminant feeds because of its high energy content and good digestibility in ruminant species.

Ethnomedical Value of *Citrus aurantifolia*

The broth of pounded leaves is drunk for stomach ache, used as an eye wash and for a bath of feverish patient. Poultice of leaves are being applied to ulcer wounds, used for skin diseases and also applied to abdomen after child birth. Crushed leaves are applied to forehead for treatment of headache and it is squeezed near the nostril for uneasy inhalation to treat nausea and bring back to consciousness for fainting individuals. Infusion of the lime leaves have been given for treatment of fever with jaundice, sore throat and oral thrush. A decoction of the flower is believed to help initiate sleep for those with insomnia.

Decoction of roots is used for treatment of dysentery, diarrhoea, colic, gonorrhoea and fever. The rind is burnt in some homes to act as good insecticide against mosquitoes. The mesocarp is used as a facial scrub to prevent pimples. The fruit oil extracted by steam distillation of the fruit rinds is used to treat different diseases such as cold, sore throat, bronchitis, asthma, arthritis and obesity. It is used as an astringent and the toning action clears oily skin acne and treat cuts. Decoction of the bark helps in relieving flatulence.

Anticancer Properties of *Citrus aurantifolia*

Acid lime has shown to inhibit colon cancer, breast cancer, neuroblastoma, pancreas cancer and prostate cancer cells. D-limonene, D-dihydrocarvone, limoniods and flavonoids are one of the major phyto-constituent responsible for the anticancer activity. [Patil RJ. (2009)]. The essential oil of *C. aurantifolia* has the maximum 78% inhibition of human colon cancer cells, DNA fragmentation and apoptosis induction which was revealed from a study and the suggestion goes for the potential use of the plant to prevent cancer especially colon cancer.

Antioxidant Activity of *Citrus aurantifolia*

Studies of the juice and fruit peels as well as leaves of *C. aurantifolia* revealed that a concentration dependent effect on low density lipoprotein (LDL) oxidation was found in the plant. The antioxidant activity of *C. aurantifolia* was ascribed to their hydrogen donating ability which may be because of the presence of flavonoids, carotenoids and Vitamin C. Flavonoids present in *C. aurantifolia* fruit juice and peels reflects their antioxidant activity by inhibiting the enzymes which are responsible for superoxide anion production such as xanthine oxidase and protein kinase C. [Yano M. (1999)]. Flavonoids also inhibit cyclooxygenase, lipoxygenase, microsomal monooxygenase, glutathione S-transferase (St), mitochondrial succinoxidase and NADH oxidase; all of whose are involved in generating reactive oxygen species. Vitamin C is predominant in *C. aurantifolia* which acts as a strong antioxidant both in vitro and in vivo. Vitamin C protects the plasma lipids and LDL against peroxidative damage which are induced by various types of oxidations. [Patil RJ. (2009)].

Immuno-Modulatory Activity of *Citrus aurantifolia*

The lime juice possesses immune-modulatory activity which was when tested in mitogen activated culture mononuclear cells. The result revealed that the juice could efficiently inhibit the proliferation of phytohaemaglutinin activated mononuclear cells at 250 and 500 microgram per litre of the juice extract. Vitamin C, one of the components of Citrus juice and peels has been shown to play an important role in enhancing immune system, fighting against the muscle damage. Several cells of the immune system, especially phagocytes and t-cells accumulate vitamin C and need the vitamin to make success their task. Thus, lack of Vitamin C results in a reduced resistance against certain pathogens whilst a higher supply increases several immune system parameters. Moreover, in this corona era, proved evidence of how the juice of this plant can protect and boost our immunity against the deadly COVID-19 virus is not unknown to us.

Nutritional Content of *Citrus aurantifolia* Fruit Juice

Lime is one of the main sources of Vitamin C. Ascorbic acid in the body helps in iron absorption from the intestines. The connective tissue metabolism especially the scar tissue is required, bones and teeth. It is a necessary anti-stress and protector against cold, chills and damp. It prevents muscle fatigue and scurvy. It is helping normal wound healing. The production of collagens has dependency on Vitamin C. It helps to promote and restore skin. [USDA. (2013)].

Conclusion

The importance of *C. aurantifolia* in the overall i-value i.e., all the properties from which we gain advantages enormously cannot be ignored. It has been traditionally used in the management of several diseases and has the aspects of being developed into useful drugs. The consumption can thus be increased either for nourishment, disease prevention or management of ailments. The plant is of economic value. The consumption of the freshly harvested, raw fruit juice is better with respect to nutritional values, as because *C. aurantifolia* juice are being incorporated into many fruit juice drinks commercially sold in the market. Finally, there should be a shift from pre-clinical screening of the plant's fruit juice, fruit peels, leaves, seed, stem barks and roots to the isolation of active compounds and the mass development of useful drugs from the plant.

However, in this era of deadly viruses and pathogens, the cultivation of such a useful plant must be increased not only in India but also in the world, overall.

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Technologies for Women in Agriculture to Reduce Drudgery

Article ID: 12006

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Introduction

In India, agriculture plays an important role in national economy. Farm women have a significant role in agricultural operations almost in each and every field activity right from tillage to harvesting. As per the estimation by 2020, the population of agricultural workers in the country will be about 230 million of which 45 % will be female workers. Highest female workers are present in Maharashtra, Tamil Nadu, Andhra Pradesh and Karnataka. Various drudgery prone activities performed by the farm women like weeding, cutting, transplanting, cleaning, sowing, bundling, picking, winnowing, collecting and bringing fodder etc. Mainly health hazards are reported in transplanting, harvesting and threshing was 50 %, drying and fodder collection was 23 -33 % (Anon, 2009).

Therefore, there is need to develop equipment considering women suitability to work in farm. Now a day's importance of women role in agriculture is recognized and importance of technologies supporting women are designed and introduced. Women friendly tools for various activities like tillage, sowing and harvesting operation was developed. This equipment is listed below.

Hand Ridger

The hand ridger was made up of ridger, T – Type handle with pulling beam. The improved equipment performed better in well prepared field. Two women are required to operate the equipment**.** Capacity of hand ridger was 330 m^2/h. Cardiac cost was reduced by 67 % as compared to existing method. Output of hand ridger is double then traditional method. Cost of equipment was Rs 700 /- (Anon, 2010).

Ciae Seed Drill

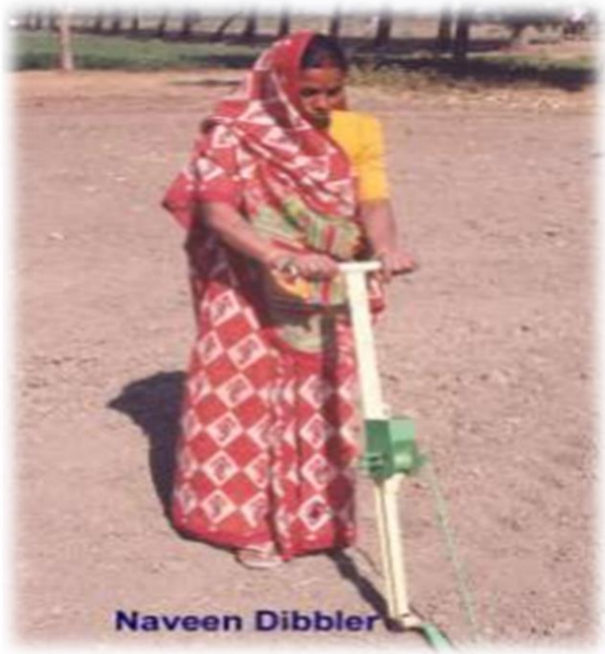
The seed drill has been modified for women workers using anthropometric data. The CIAE seed drill made up of handle, hopper, peg type ground wheel, cell type seed metering mechanisms is used. The metering roller is mounted on the ground wheel shaft. Two workers are required to operate the seed drill. Capacity of CIAE seed drill was 430 m^2/h. Output is 18 times more than traditional method. As compared with the traditional method 87 % saving in Cardiac cost of worker per unit of output. Cost of equipment was Rs 5000 /- (Anon, 2010).

Pau Seed Drill

The PAU seed drill has been modified for women workers using anthropometric data. It is made up of handle, seed hopper, ground wheel, fluted roller type seed metering mechanism and hook arrangement is provided to pull the seed drill. It is provided with peg type ground wheel and seed metering mechanism is operated through chain and sprocket arrangement. Two workers are required to operate the seed drill. Capacity of the seed drill 430 m^2/h. Output is 18 times more than existing method. Apart from 87% of cardiac cost of workers per unit of output will be saved. Cost of equipment was Rs. 5000/- (Anon, 2010).

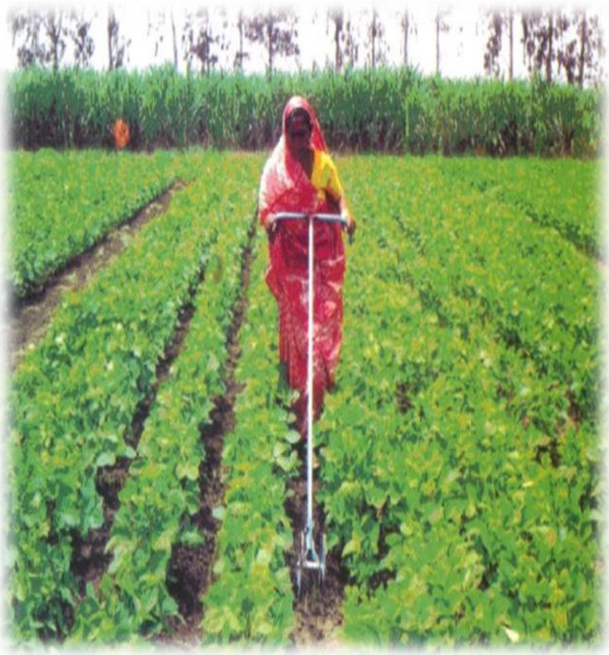
Naveen Dibbler

This dibbler made up of jaw type seed placement device, cell type seed metering mechanism, lever type power transmission system provided to transfer the power to the roller and jaws and MS type seed box is provided. The seed box should be filled with desired level and seed should be sown at desired place by pushing the lever gently. Capacity of naveen dibbler was 150 m^2 /h. About 13% cardiac cost of workers per unit of output with the dibbler was saved as compared to existing methods. Cost of equipment was Rs. 700/- (Anon, 2010).



Twin Wheel Hoe

Twin wheel hoe type weeder used for weeding and interculture operation in row crops special in black soil. It made up of two wheels, V blade, MS frame U clamp and tyne. By push and pull action the weeds are removed. The equipment is operated in field where soil moisture should be optimum and it is used after 20 -25 days of crop growing stage. Capacity of weeder was 150 m^2 /h. About 43 % of cardiac cost of workers per unit of output was saved. Cost of equipment was Rs. 800/- (Anon, 2010).



Improved Sickle

Improved sickle made up of serrated blade with wooden handle. Cutting of crop stalk is being done by sawing action. Due its light weight and it reduce the drudgery over the women during harvesting operation. Capacity of improved sickle was 150 m^2 /h. About 15% of cardiac cost was saved as compared to local sickle. Cost of equipment was Rs. 60/- (Anon, 2010).

Groundnut Stripper

The groundnut stripper made up of square frame with vertical legs and a horizontal strip is provided to expanded metal fixed on each side of the frame to form like comb. A small adjustable stool was provided for the operator to operate the stripping operation by sitting position. The height of the stool can be adjusted as per the anthropometric data of women worker. Capacity of the groundnut stripper was 11 kg/h/women. Output capacity was 350 kg of pod /day as compared to the older methods. To avoid the squatting posture and it minimize the stress at knee. About 79% of Cardiac cost of worker per unit output is saved as compared to the convectional practice. Cost of equipment was Rs. 2500/- (Anon, 2010).

Conclusions

Improved tools reduced the drudgery in almost at every stage of operation i.e., in sowing, transplanting, weeding and threshing. Serrated sickle is women friendly tool because the assessment of technology increased the efficiency and reduced the drudgery and it avoids bending and squatting posture. All these equipments could be used on custom hiring center for income generation apart from reducing drudgery.

Drudgery and health problems can be reduced by using these improved tools and also there would be improvement in their livelihood.

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E-ISSN: 2581 - 8317

Precision Agriculture

Article ID: 12008

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It is adopted by the farmers to optimize their use of resources, be it water or fertilizer, aiming to bring efficiency to the farm in terms of cost, yield, etc. further, it supports decision making in irrigation, crop management, water optimization, and the like. Precision agriculture technologies ranging from robots, sensors, drones, satellite imagery, big data and internet of things (IoT), among others, are employed in various stages of agriculture from environment analysis, irrigated landscape mapping, soil analysis, to crop health analysis. These technologies bring in reliable quality data which help in timely crop damage assessment, advance crop planning, diversification and contingency planning. Here are few examples of technologies in precision agriculture.

1. Weather forecasting and monitoring, thus providing agri-risk solutions with a high level of accuracy in the short, medium and long term too is an important innovation.

2. Numerous innovators with solar powered phase change enabled materials are offering products for irrigation and cold storage, with the aim of catering to smallholder farms and regions with limited or no electricity.

3. Eco-friendly crop protection methods also coming up, that have the potential to minimize a significant proportion of the damage caused by pests and diseases without overdosing crops and plants with chemicals, thus preventing soil and water contamination.

4. Sensor capable of providing farmers with information about crop yield, rainfall, pest infestation, and soil nutrition are invaluable to production and offer precise data which can be used to improve farming techniques over time.

5. IoT is leveraged to remotely monitor sensors that can detect soil moisture, crop growth and livestock feed levels, remotely manage and control their smart connected harvesters and irrigation equipment, and utilize AI-based analytics to quickly analyze operational data combined with third party information, such as weather information, such as weather information, to provide new insights and helps in decision making that is crop selection, crop outputs, etc.

6. Drones is an invaluable tool for farmers as they help them scan fields, monitor crops, seeding and analyze plant health, among others. Drones with advanced sensors and imaging processing capabilities can capture highly accurate images of the field, which expose everything from irrigation problems to soil variation and even pest and fungal infestations by seeing crops from the air. Drones are also being used to spray chemicals on crops while being careful not to penetrate groundwater. Recent studies have shown that drones can increase the speed of spraying by five times compared to other types of machinery.

India has recently unveiled its 'drone regulations policy'. These guidelines will foster technology and innovation in the development of drones' devices which have an extensive range of applications ranging from disaster relief to agriculture. A Hyderabad- based engineering design service company in south India are working together on a precision agriculture project to monitor farms using drones in order to monitor and act on crop health.

Data enables agriculture to combines the application of sensors connectivity, drone, data storage and aggregation, optimization hardware, software platforms, big data analytics and IoT, converting traditional farming into smart farming.

The Indian government is also serious about leveraging new-era digital technologies for agriculture. In May 2018 the NITI Aayog, the government's main think tank, signed an agreement with one of the big software firms to develop a model for crop-yield predictions using artificial intelligence (AI) so that farmers can be provided real time advisories.

Internet usage by 2020 in rural India is expected to be 315 million and it may lead to penetration in rural areas and that would be the inflection point for the agtech market in India. Agriculture startups can unleash umpteen opportunities to strengthen the supply chain in Indian agriculture. We really need to move with a sense of urgency to apply these new tools to accelerate the pace of agriculture development.

The common barriers to commercialization and scaling up of technology are access to finance, cash flow management, gaps in technology infrastructure, limited access to institutionalized farmer networks, amongst others. For innovation and entrepreneurship to be effective in transforming agriculture in India, it will be important to address these issues and create an enabling environment in which they can grow and flourish.

Importance of Nematodes in Agriculture

Article ID: 12009
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Introduction

Nematodes are among the foremost abundant animals on Earth and they are found in almost all the habitats. They are profusely present in marine, freshwater, and in soil. Nematodes are associated with plants, insects, different invertebrate and vertebrate animals as well as domestic animals and even human beings. Soil is an excellent primary habitat for nematodes. In soil, most of the nematodes exhibit role with agriculture significance and those nematodes are plant parasites as well as free living nematodes. Free soil nematodes play an important role in decomposition of organic matters in soil and are beneficial to plants.

Importance of Nematodes in Agriculture and Health

1. Improving soil fertility.
2. Biological Pest control.
3. Decomposition of organic matters.
4. Bioindicators of soil health.

Nematodes in Improving Soil Fertility

Free-living soil nematodes are of great ecological importance because they are the most common, abundant, and genetically diverse organisms found in several habitats of soils. The free-living soil nematodes form a large proportion of total soil nematodes consisting of different trophic groups such as bacterivores, fungivores, predators and omnivores. Depending on their trophic group, bacterivores feed on bacteria and other microflora; the fungivores have feeding habits on fungal mycelium, hyphae and conidia, including pathogenic fungi of the plants; the predatory nematodes feed on invertebrates such as protozoa, nematodes and rotiferes and omnivorous feed on algae, bacteria, fungi, protozoas, rotiferas, tardigrads, etc. These trophic groups exhibit interactions with other microorganisms and participate in fundamental ecological processes in the soil directly or indirectly. Because of their abundance, rapid life cycle and strong interactions with other soil microbes and predators, free-living nematodes play a key role in decomposition of organic matter and nutrient cycling. Free-living soil nematodes feed on primary decomposers of plant and animal debris that contribute to the carbon cycle and increase soil mineralization and soil nutritional element which are accessible for plant roots. They also regulate release of phosphorus and nitrogen from microorganisms they digest, immobilize nutrients in their live tissues and release excess nitrogen such as ammonium.

Nematodes contribute directly to nutrient mineralization through their feeding interactions. For example, bacterial-feeding nematodes consume N in the form of proteins and other N-containing substances in bacterial tissues and release excess N in the form of ammonium, which is readily available for plant use. Indirectly, nematodes promote the decomposition and nutrient cycling by feeding and rejuvenating old, inactive bacterial and fungal colonies, and by dispersing bacteria and fungi from newly available organic residues. In the absence of feeders, such as nematodes and protozoa, nutrients can remain immobilized and unavailable for plant uptake in bacterial and fungal biomass.

Bacterial-feeding nematodes are the most abundant nematode groups in agricultural soils. Most of them closely follow the bacterial populations, which often increases during soil disturbances, such as farming, which increases the availability of organic matter. Nitrogen mineralization in the soil occurs at a higher rate when bacterial-feeding nematodes are present. The contribution of bacterial-feeding nematodes to soil N supply depends, in part, on the quality and quantity of soil organic matter fueling the system. Net N mineralization from decomposing organic residues takes place when the carbon:nitrogen (C:N) ratio of organic residue is less than 20 (i.e, 20 parts C to 1 part N). When the C:N ratio is greater than 30, the mineralization rate decreases because microbes compete for N to meet their nutritional requirements. In this case, N is immobilized in the microbial biomass. Fertilize, compost, and cover crops with intermediate C:N ratios (ranging from 10 to 18) can promote bacterial growth and the abundance of bacterial-feeding nematodes, and increase soil N availability to plants.

Fungal-feeding nematodes are relatively more abundant in less-disturbed (e.g., notill systems) and perennial systems, where conditions for fungal growth are promoted. Like bacterial feeding nematodes, fungal-feeding nematodes contribute to the nutrient mineralization process by releasing N and other plant nutrients from edible fungal tissue. However, in agricultural systems, bacterial-feeding nematodes typically release more inorganic N than fungal-feeding nematodes.

Nematodes as Biological Pest Control

Certain nematodes are beneficial as biological control agents, as they infect certain lepidopteran and coleopteran insects and kills the insect in a short period of time. Some predator nematodes attack and kill a range of pests such as borers, grubs, thrips and beetles. These nematodes are known as 'entomopathogenic' nematodes. Important EPNs nematodes include members of the families Steinernematidae and Heterorhabditidae that have been shown to kill soil-based insect pests within24- 48 hours.

Phamarhabdita hermaphrodita is an example of slug parasitic nematodes. As a parasite of various slug species (e.g., members of the families Arionidae and Milacidae etc), the nematode controls slugs by releasing bacteria inside the host that kills the host in about 21 days. The mermithid nematodes such as *Mermis* spp., *Romonomermis* and *Agamermis* are good examples of Entomophilic nematodes. In their environment, they have been shown to affect arthropods.

Nematodes in Decomposition of Organic Matters

Nematodes are very important in agriculture in various ways, in terms of decomposition of organic matter, improving soil fertility and recycling of nutrients in an ecosystem. Beneficial nematodes act as an intermediate decomposer which is responsible for the breakdown of organic matter by broking down for decomposition process done by microorganisms such as bacteria and fungus.

Free living nematodes in soil are very important for decomposition of organic matter and nutrients recycling in the soil. Bacterial and fungal feeding nematodes doesn't feed them directly, but they feed bacteria and fungi that decompose organic matter. The presence bacteria and fungi feeding nematodes has been used to accelerate the process of decomposition of organic matter. Therefore, presences of these nematodes are used to recycles minerals and other essential nutrients from microorganisms such as bacteria and fungi in the soil where they are available through the roots of the plants.

Nematodes as Biological Indicators of Soil Health

Free-living nematodes are also used as bioindicator to assess the soil condition. Nematode species used as bioindicators on the soil health are depends on the condition of soil environment, climate and seasons, variety of crops and others. Thus, these dependence on nematodes indicates that soil health conditions, diversity and complexity of nematode species in the soil, which are a valuable tool for determining soil fertility and soil health.

However, it is difficult to measure as there are thousands of different nematode species occurring at very high rates. Also, their life cycles are short (hours or days), and so their populations change rapidly in response to changes in environmental conditions such as moisture and temperature.

There are many reasons why nematodes are commonly used as biological indicators:

1. Nematodes occur in all types of soil. Even in relatively poor soils, there are millions in every square metre.
2. Nematodes are readily extracted from soil and their food sources can be determined by looking at their mouth parts under a microscope.
3. Nematode's feed on the plant roots and on all the organisms that live in soil (e.g., bacteria, fungi, algae, diatoms, protozoans, rotifers, tardigrades, springtails, arthropods, oligochaetes and nematodes) as well.

4. Nematode numbers fluctuate in response to the population dynamics of the organisms they consume, and are also influenced by the soil physical and chemical environment.

Nematodes such as *Caenorhabditis elegans, Panagrellus redivivus, Plectus acuminatus*, *Heterocephalous pauciannulatus*, *Pristionchus pacificus, Cruznema tripartitum, Acrobeloides* sp. *and Aphelenchus* sp. are used as a bioindicators. *Clarkus* spp., *Acrobeloides* spp. and *Aphelenchus* spp. are used as a bioindicator for soil health assessment. *Caenorhabdits elegans, C. briggsae, Panagrellus redivivus* and *P. silusiae* are used as a bioindicator for environmental pollution. *Rostellascaris oceanica* nematode is a bioindicator for marine and fresh water habitats.

Advantage of Using Nematodes as Indicators

Nematodes are among the simplest metazoa which occur in any environment providing a source of organic carbon, under all climatic conditions and in habitats that vary from pristine to extremely polluted:
1. They do not rapidly migrate from stressful conditions and many species survive in dehydration, freezing or oxygen stress;
2. Nematodes are transparent and hence their diagnostic internal features can be seen without dissection and can therefore, be identified without biochemical procedures;

There is a clear relationship between structure and function, and nematodes respond rapidly to disturbance and enrichment: increasing microbial activity leads to changes in the proportion of bacterial feeders in a community.

Conclusion

Nematodes are large in population and diversity around the globe, which makes them the primary decomposers in most environments feeding by bacterial and fungal feeding nematodes enable nutrients and minerals which are essential to the plants, to be recycled from decaying organic matter. Thus, presence of beneficial free-living nematodes plays an essential role in decomposition of organic material and recycling of nutrients in the soil, which inturn will be utilized for plant growth.

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WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Molecular Dissection of Traits

Article ID: 12010

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Introduction

The molecular dissection of traits involves identifying the number and location of genes responsible for the expression of a phenotype. It is done through Quantitative Trait Loci (QTL) analysis that requires both phenotypic data (direct trait measurements) and genotypic data (data obtained using molecular markers). QTL analysis is a statistical method which links the phenotypic data to genotypic data to explain the genetic basis of variation underlying complex traits. QTL analysis helps to detect the nature of gene action, linkage or pleiotropy, transgressants, heterosis and genotype x environment interaction in a trait.

Gene Action

The phenotypic effect of a gene depends upon the number and nature of alleles present in an organism. The nature of gene action is usually studied involving a hybrid with its parents having two different alleles with distinct phenotypes. Among them, the hybrid is heterozygous carrying one copy of each parental allele. In the conventional genetic analysis finding alternative alleles for each trait is a great task. The molecular marker alleles can be associated to each of the QTLs responsible for a phenotype. Based on this association, the average phenotype of individuals carrying 'no copy' 'one copy' or 'two copies' of the marker allele can be estimated. The change in phenotype per additional copy of the allele is whether towards additivity, dominance/recessive or over-dominance can be found out by adopting specific statistical analysis. For determining the gene action, the ideal population is an F_2 population having the genotypes segregating in a Mendelian fashion. The back cross populations or recombinant inbred populations are not suitable for determining the gene action, since these populations will not have all the three Mendelian genotypes (no recessive genotypes in back cross population; no heterozygotes in recombinant inbred population). The gene actions for various quantitative traits have been predicted using the marker-based QTL analysis.

Linkage or Pleiotropy

The phenotypic expression of a trait can be due to the effect of a single gene or sometimes due to the combined effect of closely linked genes. Occasionally a single locus may have control over different traits and the phenomenon is known as pleiotropism. Distinguishing linkage from pleiotropy is not possible in many occasions and the marker-based QTL mapping facilitates to determine whether an association between different traits is due to several linked QTLs or to a single QTL with inseparable effects.

Transgressive Segregation

Transgressive segregation is defined as the appearance of individuals in a segregating population that fall beyond their parental phenotypes. It may be due to any of the following: *de novo* mutation, complementary action of genes from the parental lines and unmasking of recessive genes. Transgressive individuals may possess characteristics that will allow them to new ecological types. The QTL mapping using the molecular markers established the fact that the occurrence of significant transgression for these traits was due to the presence of complementary QTL alleles from the two parental lines.

Heterosis

Heterosis is a phenomenon related to heterozygosity resulted by mating two individuals. The level of heterosis is usually low when the parents are closely related. There are two theories on the genetic basis of heterosis: dominance theory and over dominance theory. It remains difficult to distinguish between dominance and over dominance as a basis of heterosis. However, molecular markers are expected to throw light on the understanding of genetic basis of heterosis. Identification of genetic factors contributing to heterosis in a hybrid using molecular markers was made in many crops.

Genotype x Environment Interaction

Genotype x Environment interaction (G x E interaction) is an essential issue in the assessment of mechanisms of inheritance as well as the prediction of performance in breeding programmes because genotypic values must be inferred from phenotypic responses. The process of QTL mapping offers an opportunity to detect the QTLs for a trait and inturn identify the QTLs which are stable across environments by testing an immortal mapping population (recombinant inbred population or dihaploid population). In general, QTLs which function consistently over a range of environments are preferred for breeding and the QTL mapping provides detection of stable QTLs across environments to use the information in practical plant breeding.

Conclusion

The expression of many traits in plants are under the control of many genes. The improvement of quantitative trait requires careful examination of the segregation of several genes governing the trait. This can be done effectively by QTL analysis which reveals the number, location and other above seen characteristics of genes contributing a particular trait by combining both phenotypic and genotypic data. The application of QTL analysis in crop improvement, especially to dissect the genetic architecture of complex plant traits is greatly helpful in selection and improvement of the targeted traits in an effective manner.

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E-ISSN: 2581 - 8317

Economic Valuation Techniques of Natural Resources

Article ID: 12011

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Introduction

Recent legislative advances in resource damage assessments have stimulated interest in natural resource valuation. Destruction assessments are carried out to identify the level of natural resource damage and to determine compensatory monetary damages. Analysts are becoming more concerned with nonuse values as part of natural resource damage assessments. Meanwhile, as the public's interest in preserving natural and environmental resources has grown, new applications of resource valuation approaches that are more sensitive to non-use values have emerged. Recreation is one of the numerous benefits that individuals and societies gain from landscapes and natural environments. In agriculture, the travel cost model has been used by Hynes et al. (2006) to estimate a farmland recreation demand function and accordingly people's WTP for using a farm commonage site. The estimation of recreation demand is a decision based upon sound professional judgment and due consideration of many information sources and factors. Many decisions are difficult because of the human tendency to be very selective and narrow at any point in time about what information is considered.

Economic Valuation Techniques of Natural Resources

When a market exactly like the natural resource exists, it's quite simple to use market-based methods to determine value. The market price approach, appraisal method, and replacement cost method are examples of these techniques. Otherwise, nonmarket procedures must be used to generate information on individual willingness to pay when market data is unavailable. Broadly there are two ways of estimating the economic value of non-marketed goods- revealed preference technique and stated preference technique (Figure 1).

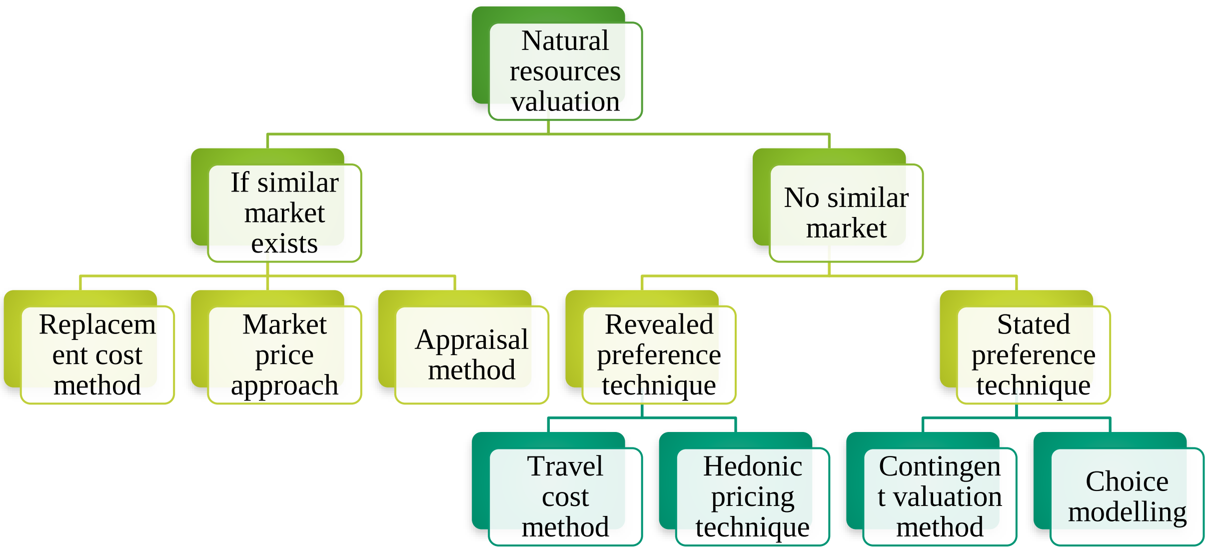

Figure 1: Different economic valuation techniques of natural resources. Source: Author's compilation

Revealed preference technique use the current transactions associated with a public commodity to estimate the value of it.

1. Travel cost method uses the cost of enjoying the environmental amenity and it is used as a proxy to value it.
2. Hedonic pricing technique- here the researchers associate the price of a marketed commodity to its characteristics or the service it provides. In stated preference techniques, the researchers ask hypothetical questions to elicit the amount the respondents are willing to pay for the improvement in the quality of

service or commodity they are receiving. Among them the first and widely used method is Contingent Valuation (CV) method used to estimation the economic benefit (Spash, 2000). Whereas, choice modeling is another stated method where respondents were asked to choose their preferred option from a set of alternatives with particular attributes. The travel cost approach, the hedonic price method, and the contingent valuation method are three of the most well-known nonmarket techniques.

Conclusion

Although controversial, some resource valuation professionals feel that, given available knowledge, scientific data, and estimating procedures, changes in service flows from ecological systems to human society can be valued in monetary terms. Natural resource valuation procedures are a developing discipline; as new case studies are done and the benefits of extra information and experience are incorporated, new lessons are learned. Ecological valuation techniques can be considered as a supplement to more standard valuation methods, however their consistency is limited due to a number of flaws and assumptions. An important objective for policy-makers is how to allocate resources for the enjoyment of its citizens. Policymakers require a realistic evaluation of the benefits and costs of activities that alter the quality and quantity of food due to resource restrictions. Economists have devised ways for assessing non-market benefits in monetary terms to aid policymakers. All of the strategies seek to express consumer demand in monetary terms, i.e., consumers' willingness-to-pay (WTP) for a specific non-marketed advantage.

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Time to Clean India's Food Laced with Toxic Pesticide Residues

Article ID: 12012

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Abstract

Pest Management as an integrated approach is used to deal with pest menace. It includes control (either physical or chemical) and preventive measures to overcome the same. India is the fourth-largest producer of pesticides in the world. But due to indiscriminate use of pesticides, they have found their way into the food chains and now pose immense health hazard. Recent studies have shown that Indian food is now laced with one of the highest amounts of toxic pesticide residues in the world. Ironically, pesticides now play a vital role in boosting food grain production in the country. As rightly said, we have gone miles past the danger zone. It's time to develop authorized agricultural practices, as well as stringent mechanisms should be put in place for controlled and judicious use of pesticides so as to avert adverse consequences in times to come.

Keywords: Pesticide toxicity, MRIs, ADI.

Introduction

Due to recent increase in health-consciousness it has now become imperative to have a precise understanding about the nature and quality of foods we consume in our daily life. Although different plant protection measures usually adopted are indispensable for obtaining good quality food in sufficient quantities so as to satisfy the needs of the burgeoning population, but indiscriminate use of pesticides for crop protection has adversely impacted environment and human health in general. Pesticides are usually used in crops in the fields by the farmers or during storage of agricultural commodities.

The residual toxicity of these agrochemicals has been associated with long-term effects on human health. Since fruits and vegetables forms an essential constituent of human diet and are usually consumed fresh

E-ISSN: 2581 - 8317

or in semi-processed state, there is a high possibility that they contain high levels of pesticide residues and may exhibit residual toxicity. Recent findings have shown that Indian foods contains one of the highest amounts of toxic pesticide residues in the world. Still rampant misuse of these chemicals continues to grow and have led to serious health hazard for Indians.

Pesticide Exposure

Foods contaminated with pesticide have negative affect on human health since many pesticides used in agriculture have high residual toxicity and may cause health hazards. Humans can be exposed to pesticides by inhalation, dermal contact or food consumption. Pesticide exposure may cause both short-term and long-term effects within human beings. The short-term effects associated with pesticide toxicity are headaches, vomiting, abdominal pain, difficulty in breathing and loss of consciousness. The long-term effects include certain types of cancer, immune and reproductive system failure apart from neurological toxicity. Children in particular are most vulnerable to pesticide toxicity. Pesticide toxicity in nursing and expectant mothers can lead to defects in neuron development, certain birth defects, asthma and cancer.

Toxicity in Foods

Vegetables

Vegetables forms an important constituent of Indian diet. They are an important source of micronutrients and dietary fibers. The vegetables are frequently seen to be laden with toxic residues of harmful pesticides. Sometimes the deliberate malpractice by farmers and vegetable vendors has also been seen i.e., methyl parathion is sprayed on cauliflower to give it an extra white appearance. Similarly, Bhindi (okra) is dipped in copper sulphate to make it look greener. And the guideline that no pesticide should be sprayed one week before the harvest is violated frequently.

Fruits

As with vegetables fruits are an important source of vitamins and other micronutrients. Studies have shown that they contain high residue level of several harmful pesticides. Grape’s apples, mangoes, citrus fruits are all laden with toxic residues of harmful pesticides, which possesses serious health hazards. Grapes are probably one of the most widely-sprayed fruits in India. Some chemicals i.e., daminozide and others harmful pesticides used in the orchards has been associated with carcinogenic activity.

Cereals

Cereals constitute an important part of Indian diet. It has been seen that wheat, rice and maize, that forms the major part of the daily diet of most Indians, are highly contaminated with pesticides. While levels in rice tend to be lower because of dehusking, in wheat, these pesticides don't degrade even when the flour is made into chappatis. The various dais also contains toxic residues, but the levels are not as high.

Milk and Milk Products

Due to ineffective controls and a lack of strict guidelines, pesticide residues have even been found in milk and milk-based products like butter, ghee and cheese. This becomes a real threat scenario since various pesticides adhere to fatty tissues in the body, milk, which high fat content, serves as an ideal storehouse for toxic pesticides. In bovine milk, contamination comes through the cattle fodder which has a high level of pesticides, due to indiscriminate use of pesticides by the farmers. Processed milk products contain even higher number of toxic residues as the residue levels gets magnified further worsening the matters.

Meat and Meat Products

Studies have shown that non-vegetarian food also contain high levels of toxic residues. As animals graze in the fields previously sprayed with pesticides or the forage crops which are used as their fodder contains toxic residues of harmful pesticides much higher than the permissible limits. Poultry birds are fed with feeds which contain high amount of residual toxicity of harmful pesticides, these residues find their way in poultry products including eggs. Similarly due to wash over from the fields sprayed with pesticides, the ponds in which fishes are raised also contain high levels of pesticide residues.

Regulatory Bodies

Governments and various international bodies including WHO regulate the use of pesticides by setting up maximum residue levels (MRLs) of pesticide in foods. It is mandatory to have pesticide residue monitoring within fruits and vegetables so as to determine exact concentrations and proper use of the pesticides. Many countries have established statutory bodies to determine the MRLs for agricultural products so as to avoid the health hazard associated by pesticide residues. The safety limits of pesticides are typically expressed as acceptable daily intake (ADI). The standard method is to evaluate human exposure based on the average consumption per person per day. In India the Insecticides Act, 1968 and Insecticides Rules, 1971 although regulates the import, registration, manufacture, sale, transport, distribution and use of pesticides with a view to prevent risk of human or animal exposures, but the scenario of residual toxicity in food and food products is still frightening.

Conclusion

Despite all the mechanisms in place to prevent risk of human or animal exposures to toxic residues of harmful pesticides, recent studies have shown that the situation is of grave concern for consumers especially children. There is need to develop authorized agricultural practices, as well as stringent mechanisms should be put in place for controlled and judicious use of pesticides. Frequent monitoring of pesticide residues in food and food products should be a priority. Central and State departments i.e., health and food should work in coordination with the farmers and consumers and other stakeholders to clean up India's food and farming.

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E-ISSN: 2581 - 8317

Quinoa – The Pseudopcereal

Article ID: 12013

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A pseudocereal or pseudograin is any non-grass that are used in much the same way as cereals (true cereals are grasses). Their seed can be ground into flour and otherwise used as cereals. They are a group of plants, which form starchy seeds, but botanically they are assigned to the dicotyledonae. Within nutrition and food-processing they are used like cereals. Quinoa (pronounced "keen-wah") is a pseudocereal scientifically known as *Chenopodium quinoa.*

Quinoa is a type of edible seed that comes in various colors including black, red, yellow, and white. The plant has been cultivated for about 5000 years and is indigenous to the Andean region of South America, specifically Bolivia, Ecuador, Chile, and Peru. After the seeds are harvested, they undergo processing to remove the natural saponins, a bitter-tasting chemical compound coating the exterior that acts as a natural pesticide.

Nutritional Value

Quinoa, often described as a "superfood" or a "super grain" has become popular among the health conscious, with good reason. Quinoa is packed with protein, fibre and various vitamins and minerals. It is also gluten-free and is recommended for people who are on a gluten-free diet.

Raw, uncooked quinoa has 13% water, 64% carbohydrates, 14% protein, and 6% fat. Nutritional evaluations indicate that a 100-gram serving of raw quinoa seeds is a rich source (20% or higher of the Daily Value, DV) of protein, dietary fibre, several B vitamins, including 46% DV for folate, and the dietary minerals magnesium, phosphorus, and manganese.

Quinoa contains higher amounts of protein and greater balance in the distribution of essential amino acids than cereals, resembling the biological value of milk protein. It exceeds cereals in the amount of lipids, proteins, dietary fibre, vitamins B1, B2, B6, C and E and minerals, mainly calcium, phosphorus, iron and zinc. In addition to presenting high nutritional quality, it is characterized by being gluten-free feature allowing to obtain a greater variety of foods more suitable and nutritious to holders of celiac disease. Furthermore, the quinoa plant is resistant to cold, salt, and drought, which leaves no doubt as to why it has been called the "golden grain".

Marketing

Between 2006 to 2017 the price was three-fold increased. There is steady growing demand for quinoa grains. However, has received much less attention than crops like maize or wheat. Its cultivation has spread to more than 70 countries, including Kenya, India, the United States, and several European countries.

Way Forward

Agronomists and nutrition scientists began researching quinoa. It became the subject of much interest among researchers involved in Neglected and Under-utilized Species studies. Quinoa could play a decisive role in food and nutritional security in unprivileged and under privileged regions of the word in line with poverty eradication in support of achieving UN - Millennium Development Goals. The crop has been selected as an experimental crop in **NASA's Controlled Ecological Life Support System** for long-duration human occupied space flights.

E-ISSN: 2581 - 8317

Scope and Importance of Floriculture

Article ID: 12014

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Scope

Total area under floriculture in India - **1 Lakh ha**.
State having maximum area under floriculture in India Karnataka.
State having maximum production under floriculture in India Tamil **Nadu.**
In India, total area under green house: 500 ha.
Largest importer of floricultural products from India: USA (27%).
Share of dry flower product in India's total export →60%. (5th in world).
Max cut flower production in India - **West Bengal.**
Flower Crop covering maximum area in India – **Jasmine.**
Punjab, Karnataka, Maharashtra & West Bengal are major flower seed production areas in India.
Famous loose flower crop in South India- C**hina aster.**
India is blessed with varied & dynamic agro climatic condition, Soil & water made Suitable for floriculture
Readily available low-cost Labour.
Singapore is the nearest International standard flower auction centre helpful for Indian exports.
High profit per unit area in comparison to other agricultural crops.
Floriculture products possess 25-30 times more foreign exchange earning ability than cereals or other agriculture/horticultural products.
Creating pleasure passion & thrill to persons engaged in flower cultivation.
Development of hotel and tourism industry.

Importance

Flowers have aesthetic value as they are symbol of beauty, love, traquility.
In our country flowers are Santified & used to worship God (it has total been estimated that more than 30-40% of the total flower productions are being consumed in Kolkata city alone used for worshipping purpose).
In day-to-day activities flowers are used for Various activities of social functions such as birthday, wedding, anniversary, welcoming, departing & dignitaries etc.
Flowers have become integral part of Interior decoration, homes, offices, hotels, restaurants, banquets halls et.
Flowers have also become part of daily self-adornment.
Perfumes extracted from flowers is used in soaps and cosmetics.
Flower products are used as source of food and also an additive in food & Sweets.
Protected cultivation of cut flowers, increases yield & income of farmer.
Flowers are highly value for their floral arrangements like floral Buttonhole, Flower Basket, Bouquet, Corsages & Wreaths.

		
Flower Basket	**Bouquet**	**Floral buttonhole**

	
Wreaths	**Corsages**

Sale of Flowers, Foliage plants, Succulent plants, Indoor plants etc is an organised business form in metropolitan towns in India in the form of Landscaping and Potted plants.

Flowers can be used prepare different Perfumery products like Rose water, Rose attar, Jasmine attar, Carnation oil etc.

Crop	Medicinal Uses	Value added products
Rose	Sedative	Gulkand, Pankuri, Rose water, Rose oil
Marigold	Wound healing	"Lutein" a carotenoid extract used in poultry feed for yellowing of egg yolk and also as insect repellent
Chrysanthemum	Treat type II Diabeties	Natural insecticide that is Pyrethroid is extracted
Orchids	Improves eyesight	Madagascar Tea
Carnation	Treat nausea	Syrup preparation and substitute for Rose petals, Carnation oil
Gladiolus	Treat Diarrhea	Used as Deserts in Africa
Jasmine	Heapatitis	Jasmine tea and Jasmine oil
Crossandra	Headache	Veni and Garland preparation
Tuberose	Sedative	Oil extraction used in Thai tuberose soup
Gerbera	Anti-Spasmodic	Cotton obtained from Gerbera lanuginosa is used as tinder and made into cloth and bags
Dahlia	Diabetes	Sweet extracted from tubers of dahlia called Dacopa

Value Added Products

Gulkand obtained from rose petals

Marigold dye extraction (Luetin)

Extracted from *Chrysanthemum cinarerifolium*

Jasmine tea

Madagascar tea

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E-ISSN: 2581 - 8317

Methodological Approaches to Consumer Preference Models in Market Research

Article ID: 12015

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Introduction

Market research is an organized effort to gather information about target markets and customers. Market research helps to identify and analyze the needs of the market, the market size and the competition. Market research is the process of determining the viability of a new service or product through research conducted directly with potential customers.

Market research allows a company to discover the target market and get opinions and other feedback from consumers about their interest in the product or service. This type of research can be conducted in-house, by the company itself, or by a third-party company that specializes in market research. It can be done through surveys, product testing, and focus groups. Test subjects are usually compensated with product samples and/or paid a small stipend for their time. Market research is a critical component in the research and development (R&D) of a new product or service.

Market research is frequently concerned with finding out which characteristics of a product or services are most important to consumers. Marketing ideally should make selling superfluous. Selling becomes superfluous when the product or service being sold meets the needs of the consumer. A consumer has a bundle of needs and a product or service is a bundle of attributes. The utilities of the product attributes have the ability to satisfy the needs of the consumer.

The task of the marketers is to identify the needs of the consumers and the value (or importance) they assign to each need. In the real world, buyers do not make decisions based on a single attribute, such as price or brand name. Instead, they examine a range of products, all with different combination of features and attributes, and perform a complex series of trade-offs before reaching a decision, many consumers are unable to accurately determine the relative importance that they place on product attributes.

Consumer preference is a marketing term meaning a consumer likes one thing over another. For instance, a trend may indicate consumers prefer using debit cards over credit cards to pay for goods. Companies rely on surveys, information and data in order to customize products and services based upon consumer preferences. The modelling of consumer preferences among multi-attribute alternatives has been of great interest and concern to consumer researchers. According to Rao (2014), Preference modelling involves identification of the choice alternatives, attributes associated with the alternatives, estimation of the relative contribution of these attributes, and the specification of a conceptual model underlying the choice process.

Conjoint Analysis

Conjoint Analysis is a statistical technique where respondents ranked preferences for different offers are decomposed to determine the person's inferred utility function for each attribute and the relative importance of each attribute. The aims of conjoint analysis were to identify attribute combinations which confer the highest utility to the consumers and to establish the relative importance of attributes in terms of their contribution to total utility. This analysis is based on models like Part -Worth Model, Vector Model, additive model and Ideal Point Model.

Researchers and managers in agricultural and food industries often face problems relating to new product development, forecasting, market segmentation and pricing decisions, advertising and distribution, competitive analysis and repositioning. So, a conjoint measurement study can assist them in solving these problems.

Conclusion

Conjoint analysis as of now is the best suited model for consumer preference. However in-depth research innovations are yet to come. There is a scope to include the role of factors like price of new products, information diffusion on attributes and competition. The respondents opined that, it's a hard task to rank 'N' number of preference cards. Hence it requires innovations in methodology of data collection.

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Precision Farming Technologies in Vegetable Crops

Article ID: 12016

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Introduction

Precision agriculture can be defined as a comprehensive system designed to optimize agricultural production through the application of crop information, advanced technology and management practices. To be a truly comprehensive system, it must begin during the planning stages of the crop and continue through the post-harvest-processing phase of production. Information, technology and management are the keys to success in this production system (Arora, 2005). It remained forgotten for quite a long time, until the availability of microcomputers, sensors and positioning systems that became available at reasonable cost. According to Goering (1993) the increasing concern with environmental factors, brought back that concept since the application of agricultural chemicals in a site-specific basis would decrease the chances of leaching of these products and environment contamination.

Precision agriculture is also known as precision farming, precision horticulture, site-specific farming (SSF), site-specific management (SSM), site-specific crop management (SSCM), and variable rate application (VRA) etc. Precision Agriculture (PA): "is an integrated information and production-based farming system that is designed to increase long term, site specific and whole farm production efficiency, productivity and profitability while minimizing unintended impacts on wildlife and the environment".

Site-specific crop management (SSCM): "A form of precision agriculture whereby decisions on resource application and agronomic practices are improved to better match soil and crop requirements as they vary in the field".

Precision agriculture vis-à-vis traditional agriculture Precision agriculture distinguishes itself from traditional agriculture by its level of management. Instead of managing whole fields as a single unit, management is customized for small areas within fields. This increased level of management emphasizes the need for sound agronomic practices. Unlike traditional crop management, which assumes uniform field conditions and recommends average input application rates, precision agriculture is information intensive.

Objectives of Precision Farming

1. Increased profitability and sustainability.
2. Optimizing production efficiency.
3. Optimizing product quality.
4. Most efficient chemical and seed use.
5. Effective and efficient pest management.
6. Energy, water and soil conservation.
7. Surface and ground water protection.
8. Minimizing environmental impact.
9. Minimizing Risk.

Potential Benefits of Precision Farming

1. Precision Agriculture Increased profits through increased efficiency.
2. Reduced agronomic inputs.
3. Better record keeping.
4. Improved production decisions.
5. On farm research.
6. Reduced environmental impact.
7. Property advantages and More ground farmed.

Constraints Involved in Precision Agriculture

Small land holdings, High-cost technology, Heterogeneity of cropping systems, Lack of local technical expertise and knowledge and Technological gaps (Moran MS, 1997). Misconceptions carried by precision agriculture Like many new concepts, PA is often confused with yield mapping. Yield mapping is a tool that is one of the first steps towards implementing a SSCM strategy. PA is sometimes misinterpreted as sustainable agriculture. PA is a tool to help make agriculture more sustainable however; it is not the total answer.PA aims at maximum production efficiency with minimum environmental impact. Initially it was the potential for improved productivity (and profitability) that drove the development of SSCM as a form of PA.

Elements of Precision Farming

1. Information: Crop characteristics like stage of crop, crop health, nutrient requirement etc. Detailed soil layer with physical and chemical properties, depth, texture, nutrient status, salinity and toxicity, soil temperature, productivity potential etc.
2. Technology: PA is an integrated agricultural management system incorporating several technologies.
3. Decision support (management): Just having information about variability within the field does not solve any problems unless there is some kind of decision support system (DSS) in order to make VRT recommendations.

Steps Involved in Precision Agriculture Adoption

1. Purchase a mapping programme.
2. Collect spatial data.
3. Keep records.
4. Obtain remote images.
5. Purchase a yield monitor.
6. Purchase a DGPS receiver.
7. Generate yield maps.
8. Use yield maps for scouting.
9. Generate profit maps.
10. Use yield and profit maps for land.
11. Take site-specific soil fertility samples.
12. Manage subfields.
13. Adopt variable rate technology (VRT) Precision farming development centres (PFDC) in India.

Conclusion

A truly comprehensive approach to precision agriculture must cover all phases of production from planning to post harvest. Information, technology and management are combined into a production system that can increase productivity, improve product quality, allow more efficient chemical use conserve energy and provide for soil and ground water protection. Technology and management practices such as field scouting, field mapping, variable rate control, yield mapping and post-harvest processing can readily be adapted to vegetable crop production. However, the technology related to precision farming needs refinement to realize benefits (Kalia, 2005).

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E-ISSN: 2581 - 8317

Non-Destructive Quality Monitoring of Fruits & Vegetables - A Review

Article ID: 12017

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Abstract

Non-destructive quality detections in post-harvest fruit were based on optical properties, sonic vibration, machine vision technique, nuclear magnetic resonance (NMR), electronic noses, electrical properties, computed tomography. The non-destructive detection methods have their strengths and weaknesses. For instance, the method of optical properties can detect the injury of fruits surface, but cannot detect the internal quality. The non-destructive detection technique is still in laboratory experiment, not applying to commercial fields. At the same time, with the rapid development of computer technology and specialization in many fields, the automation of fruits measurement will come true. Therefore, it is essential that simple, quick, accurate and comprehensive detection methods apply to the research and application in the future. In addition, the combination of machinery and optics technology, multi-spectrum technology and machine vision technology should be strengthened.

Keywords: Fruit quality; non-destructive detection; research; application.

Introduction

Quality of fruits and vegetables may be defined as the composite of those characteristics such as sensory properties, nutritional value, safety and defects. The quality is mostly based on the evaluation of various external and internal factors. Size, shape, colour, gloss, firmness, texture, taste and freedom from external defects such as visible blemishes, dullness, etc., are various external quality factors of importance. Destructive methods rupture the fruit tissue, can be used to assess internal variables of fruits. Non-destructive methods are effective than traditional conventional methods as non-destructive methods are mainly based on physical properties which correlate well with certain quality factors of fruits and vegetables. It is useful in sorting superior quality fruits from substandard fruits based on their size and shape of fruits and vegetables which are free from internal defects such as internal bruises, pits, cavities etc. Colour, acidity and dry matter are various variables used to measure maturity of fruits (Lakshmi *et al.,* 2017).

Single non-destructive method is difficult to assess for external and internal quality evaluation. Hence, various methods are used to assess in detection of internal defects, or indirectly by correlating the results obtained on assessing other chemical or physical characteristics, for example, measurement of maturity is based on colour or firmness (Tables 1). Various non-destructive methods used in the quality evaluation can be classified as:

1. Mechanical methods
2. Optical methods
3. Electromagnetic methods
4. Dynamic methods

Table 1: Non-destructive methods to determine particular quality characteristics of fruits and vegetables:

Non-destructive technique Quality characteristics	Quality characteristics
Impact test	Firmness, internal damage, etc.
NMR	Maturity, pit detection, freeze damage, heat injury, worm damage, sugar content, infections, moisture & oil content, etc

MRI	Morphology, Maturity, Core breakdown, Pit detection, worm damage, freeze damage, heat injury, etc.
X-ray	Moisture content, density states, freeze damage, internal browning, bruises, tissue damage, tunnel or pit detection, presence of insects, etc.
NIR	Soluble solids, firmness, acidity, dry matter, Sugar content, Freeze damage, post-harvest defects, rapid analysis of moisture, fat & protein content, etc
Acoustic	Firmness, internal defects, internal cavity detection, etc
UV-VIS spectroscopy	Carotene content
Fluorescence spectroscopy	Freshness, ripeness, surface bruises, etc
Ultrasound	Maturity, defects, sugar content, firmness, moisture & oil content, etc.

Mechanical Methods

Mechanical methods include low mass impact test, microphone test and electronic nose methods. It is useful in the assessment of fruit texture by measuring stiffness and elastic properties which are related to turgor pressure and water loss, then to mechanical strength of cell wall and middle lamella (Sheeja & Ajay 2016).

Optical Methods

Optical properties of fruit are based on reflectance, transmittance, absorbance, fluorescence or scattering of light. Soluble solid content (SSC), acids, starches and overall maturity of fruits can be analysed by using spectral-optical methods non-destructively. This method includes image analysis (analysis of size, shape, colour and external defects); visible/near infrared spectroscopy (VIR); laser spectroscopy; reflectance, transmittance and absorption spectroscopy.

Electromagnetic Methods

Electromagnetic spectrum consists of radio wave, microwave, ultraviolet rays, visible light, infrared rays. The nuclear magnetic resonance technique involves NMR spectroscopy, NMR relaxometry and magnetic resonance imaging (MRI). Principle involves the absorption of magnetic energy by the nuclei placed in an alternating magnetic field. The amount of energy absorbed by the nuclei is directly proportional to the number of protons present in a particular sample. Water and oil content in a sample can be determined by using this technique. This method is also useful in the detection of pits in fruits and vegetables. This is advantageous over other methods as it is simple and spectra can be interpreted easily. Hernandez-Sanchez, et al. 2004 had used MRI to differentiate healthy and freeze damaged oranges. Undamaged oranges produced high and homogeneous signal intensity. Whereas, freeze injured oranges exhibited low intensity-signals. Freeze damage was confirmed by visual inspection (Baldwin 2011).

Dynamic Methods

X-ray falls between gamma rays and ultraviolet rays. It covers the wavelength range of 0.01-10 nm. Maturity and various internal defects in fruits can be analysed by using this technique. Physiological defects in the tissues viz. freeze damage or internal browning or presence of pits, presence of foreign particles, infested fruits, etc. exhibit changes in density and water content. Thus, substandard fruits can be easily distinguished from healthy fruits. X-ray radiography and x-ray computed tomography (CT scanning) are widely used methods. X-ray radiography produces 2-dimensional (2D) images whereas x-ray computed tomography produces 3-dimensional images (3D). Yang, et al., 2006 had examined the internal injuries caused by insects such as *Bactrocera dorsalis* at various time intervals using X-ray imaging. Apple, pear, peach, cherry tomato and orange were the fruits selected for the study. The tunnels formed by the insects were detected successfully.

Conclusion

Non-destructive methods/techniques (NDT) measure the physical properties of fruits and vegetables; and correlate with the desired quality factors (dry matter, sugar content, water content, fat content, pigment concentration, etc.) by using various data analysis methods. Non-destructive methods facilitate the grading

E-ISSN: 2581 - 8317

of fruits and vegetables based on their size, shape, maturity or ripeness. It is useful in the detection of external (deformation, discolouration) as well as internal defects (internal browning, internal bruises, freeze damage, presence of insects in the core, etc. Non-destructive methods can be used in fields to measure the fruit maturity on trees; in laboratories for sampling purpose and also in industries such as fruit processing, packaging and ware houses for continuous quality monitoring by adopting online systems. Although, Non-destructive methods are not suitable to measure all the chemical and physical quality parameters. High cost of equipment used and usage of different instruments to analyse different parameters are the major disadvantages of non-destructive methods.

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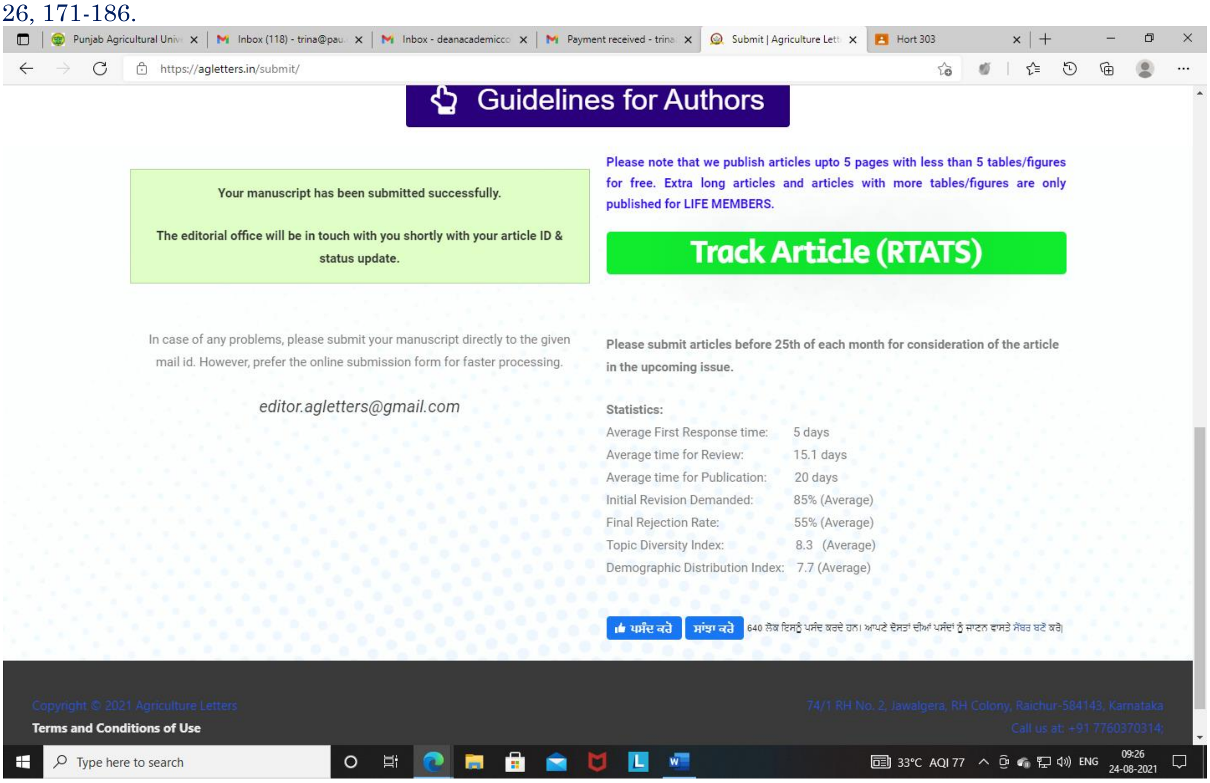

QTL - Seq Analysis: A Novel Technique for Precise Mapping of QTLs

Article ID: 12018

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What is QTL – Seq?

QTL- seq is a molecular technique that combines bulk segregant analysis and high throughput genome sequencing to detect major locus of quantitative traits of interest in segregating populations.

It is an improved version of BSA where markers like RAPD, SSR, RFLP have been replaced with SNPs accompanied with high throughput resequencing and SNP index analysis.

Why to Go for QTL-Seq?

Though QTL mapping has been efficient in identifying QTLs for various traits, it often involves genotyping of large number of individuals/plants with a greater number of molecular markers that adds up to the experimental cost. Bulked segregant analysis (BSA) on the other hand tries to reduce genotyping costs to some extent. Although many quantitative trait loci (QTLs) underlying major traits have been dissected out using methods like QTL mapping, association mapping etc., the confidence intervals for the detected QTLs were too large. Hence, to more precisely map QTLs at reduced costs a new methodology combining bulk segregant analysis with NGS technologies was devised *i.e.,* QTL -seq. This technique does not need marker development. The QTL-seq method has been used to detect QTLs in rice, cucumber, tomato, groundnut and foxtail millet (Illa-Berenguer *et al*. 2015, Lu *et al*. 2014, Masumoto *et al*. 2016, Pandey *et al*. 2016, Wei *et al*. 2016). With the ever-decreasing costs of whole genome sequencing (WGS) and genome sequences of most of the crops being done, Quantitative Trait Locus Sequencing (QTL-seq) assumes more prevalence. Even though sequencing cost has decreased substantially, many researchers still try to weigh the tradeoffs between higher sequencing depth and cost savings. The efficiency of QTL-seq lies in the simplicity of sequencing only two samples. It detects one loci at one time for a trait, while QTL mapping gives several loci for one trait in a single study.

Procedure

1. Generation of suitable mapping population of sufficient size by crossing diverse parents for the target trait.
2. About 50 plants from the two extreme classes (high and low phenotypic classes) of the mapping population were taken to constitute high and low bulks, respectively.
3. Equal quantities of DNA from all the plants constituting respective bulks are taken to generate the two DNA bulks.
4. The two DNA bulks are sequenced separately using a NGS method
5. Short sequence reads are aligned against a reference genome of one of the parents
6. Compute and compare SNP index for the high and low bulks
7. The SNPs showing contrasting patterns in the two bulks denote the QTLs governing the target traits.

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E-ISSN: 2581 - 8317

Electrolytes: Important to Stay Healthy

Article ID: 12019

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Introduction

Electrolytes are minerals found in bodily fluids that carry an electric charge and are essential to keeping the heart, nerves and muscles functioning properly. The kidneys play an important role in ensuring that electrolyte levels remain invariant despite any changes the body may undergo. Having an excess or an insufficiency of electrolytes in the body can be dangerous and, in some cases, fatal.

One of the major roles of electrolytes is to ensure that fluid levels inside and outside the cell is balanced. The cell can adjust its fluid levels by changing the concentration of electrolytes. For example, an increase in electrolytes within the cell draws more fluid in whereas a decrease in electrolytes promotes an efflux of fluids. Sustaining this type of osmotic gradient is essential for nerve and muscle function, hydration, and maintaining blood pH levels. Additionally, electrolytes carry electrical impulses across the cell and to neighbouring cells in order to promote muscle contractions and nerve impulses.

The most common electrolytes found in the body are calcium, sodium, potassium, phosphate, chloride and magnesium. The serum values and individual functions for these electrolytes are:

1. Sodium is the major cation (positively charged ion) found outside the cell. It regulates the total amount of water in the body and plays a major role in neuronal and nerve signaling. Normal serum sodium values range from 135 -145 milliequivalent/liter (mEq/L).
2. Potassium is the major cation inside the cell. Potassium is essential for the proper functioning of the heart, kidneys, muscles, nerves, and digestive system. The normal blood potassium level is 3.5 -5.0 mEq/L.

Chloride is the major anion (negatively charged ions) found outside the cell. Chloride plays a critical role in keeping the proper balance of body fluids and maintaining the body's acid-base balance. The normal chloride values are 96-106 mEq/L.

Electrolyte Imbalance

An electrolyte imbalance can develop as a result of either having excess or a deficiency of electrolytes in the body. An electrolyte imbalance may be caused by:

1. Loss of body fluids: may be caused by prolonged vomiting, diarrhoea, sweating or high fever.
2. Poor diet.
3. Malabsorption: the body may be unable to absorb electrolytes due to a variety of stomach disorders.
4. Hormonal or endocrine disorders.
5. Kidney disease.
6. Certain medications: chemotherapy drugs, diuretics, antibiotics, and corticosteroids.

A majority of the electrolyte related health problems occur when levels of sodium, potassium or calcium are unbalanced. Hypernatremia (having an excess of sodium) is the most common type of electrolyte imbalance.

Symptoms of Electrolyte Imbalance

Symptoms will depend on which electrolyte is out of balance and whether the level of that substance is too high or too low. A harmful concentration of magnesium, sodium, potassium, or calcium can produce one or more of the following symptoms:

1. Irregular heartbeat.
2. Weakness.
3. Bone disorders.
4. Twitching.
5. Changes in blood pressure.
6. Confusion.

7. Seizures.
8. Numbness.
9. Nervous system disorders.
10. Excessive fatigue.
11. Convulsions.
12. Muscle spasm.

Treatment of an Electrolyte Imbalance

Treatment of electrolyte imbalance may vary depending on the underlying cause or which electrolyte is imbalanced. Treatments include:
1. Intravenous fluids.
2. Dietary changes. Minor electrolyte imbalances may be remedied by dietary changes. For example, consuming more potatoes, bananas or avocados will increase potassium levels. Eating more leafy green vegetables will increase magnesium levels. Increasing the intake of celery and yogurt will increase sodium and calcium levels, respectively

In order to stay healthy, it is critical to replace electrolytes lost through sweat or as a result of a poor diet. A diet that includes whole grains, leafy greens, fresh fruits and vegetables usually provides the electrolytes for body needs. It is also important to supplement diet with sports drinks or fruit juices when participating in strenuous activity.

Monitoring

An electrolyte panel is used to screen for imbalances of electrolytes in the blood and measure acid-base balance and kidney function. This test can also monitor the progress of treatment relating to a known imbalance. Levels are measured in millimoles per liter (mmol/L) using the concentration of electrolytes in the blood. If the level of a single electrolyte is found to be either too high or too low, the doctor will keep testing this imbalance until levels are back to normal. If an acid-base imbalance is found, the doctor may carry out blood gas tests. These measure the acidity, oxygen, and carbon dioxide levels in a sample of blood from an artery. They also determine the severity of the imbalance and how the person is responding to treatment. Treating an electrolyte imbalance involves either restoring levels if they are too low or reducing concentrations that are too high.

The type of treatment will also depend on the severity of the imbalance. It is sometimes safe for an individual's electrolyte levels to be replenished over time without ongoing monitoring.

Oral rehydration therapy: This treatment is used mainly for people experiencing an electrolyte shortage alongside dehydration, normally following severe diarrhoea. The World Health Organization (WHO) has approved a solution to be used in oral rehydration therapy that contains 2.6g of sodium**,** 1.5g of potassium chloride**,** 2.9g of sodium citrate. These are dissolved in one liter of water and given orally.

Electrolyte replacement therapy: In more severe cases of electrolyte shortage, the substance can be given to the individual either orally or through an intravenous drip. A shortage of sodium, for example, can be supplemented with an infusion of saltwater solution or compound sodium lactate. An excess can occur if the body loses water without losing electrolytes. In these cases, a solution of water and blood sugar, or glucose, is given.

Prevention: Some causes of electrolyte shortage, such as kidney disease, cannot be prevented. However, a well-managed diet can help reduce the risk of a shortage. Consuming a moderate amount of a sports drink following physical exertion or exercise can help limit the impact of losing electrolytes in the sweat.

Conclusion

The human body is an intricate system with sensitive chemical balances. It's important that delicate electrolyte balance to be maintained. Any disruption in the electrolyte balance can have a cascading effect, with some more severe than others. To prevent any disruption or disturbance, it is vital to maintain a healthy diet. The best way to maintain a healthy body is to have a nutrient-rich, well-balanced diet, while avoiding added sugars, junk foods, fats, and excessive carbohydrates.

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Importance of Mechanical Harvesting of Finger Millet Crop

Article ID: 12020

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Summary of Article

Finger millet is a dry land crop cultivated in both tropical and sub-tropical regions. Apart from providing grain millets can be a valuable source of forage because of their rapid growth, high nutritive value, and ability to survive under stressful conditions such as drought. To serve both as grain and fodder the finger millet crop has to be harvested separately as ear heads and then stalks. Proper harvesting time is an important factor in cultivation of finger millet. The area under finger millet cultivation is decreasing due to scarcity of labor for manual harvesting of finger millet. Hence mechanization plays a very important role in harvesting of finger millet.

Introduction

Finger millet, also known as ragi, is valued as staple food in south India (Karnataka, Tamil Nadu, and Andhra Pradesh) and in hilly regions of the country. Finger millet is often referred as coarse cereal. Finger millets can be grown even in poor soil and climatic conditions of low rainfall and intense heat. They have short growing period and can be very well fitted into multiple cropping systems both under irrigated as well as dry farming conditions. They can provide nutritious grain and fodder within a short span of time. These crops fit well into rotational systems when emergency summer forage is needed. Proper harvest timing is critical in order to achieve maximum feed for animals requiring high nutrition.

Production of Finger Millet in India

In India, it is extensively grown in Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Bihar, Gujarat and Maharashtra and the hilly regions of Uttar Pradesh and Himachal Pradesh. Karnataka is the leading producer of finger millet with 53.94 per cent of the total area and 53.36 per cent of the total production of the crop in the country. Tamil Nadu occupies second place in respect of area (7.52 per cent) and production (14.60 per cent) of finger millet in India. The chief producers are Coimbatore, Dharmapuri, Ramanathapuram, Salem, North and South Arcot, Nilgiris, Chengalpet. The area under finger millet has declined from 2.6 million ha in early sixties to around 1.06 million hectares in 2018-19.

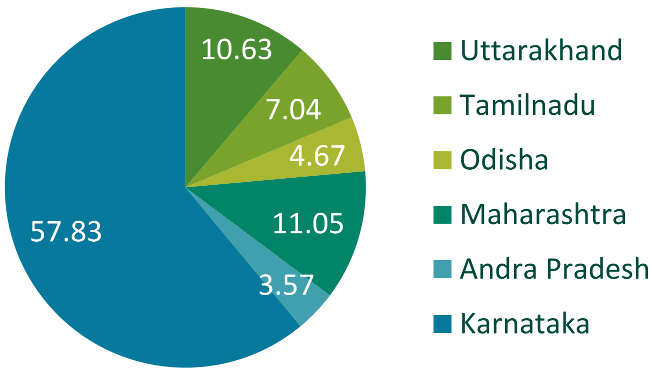

Figure 1 Percent of area occupied by finger millet in major states of India (2019-20)

Finger Millet as Fodder

Finger millet is cultivated as a fodder grass in many countries (India, the USA and Ireland). The straw of finger millet has immense utility as fodder. Silage is also made from finger millet forage at flowering stage. Straw makes valuable fodder for both draught and milch animals. It provides excellent hay and is used as green forage for cattle, sheep and goats (Chaab *et al.,* 2018). The straw resulting from the grain harvest is valuable and can be grazed directly by the animals or used in cut-and-carry feeding systems. Baath *et al.,* (2018) reported that finger millet can generate forage yields ranging from 5.0 to 12.3 Mg ha^{-1}.

Harvesting

The finger millet crop attains flowering stage in 60-80 days and matures in about 120-130 days depending on the variety. The finger millet has a shallow root system which is difficult to pull out. Hence, they are harvested by sickle or scythe when the crop reaches physiological maturity. Stems and leaves (up to 75 cm long and 2 cm broad) are usually green.

Finger millets are harvested when the ear heads turn brown. Finger millet crop does not possess a uniform maturity. Hence the ear heads including the green ones are harvested and put into curing to obtain uniform maturity by heaping the harvested ear heads in shade for one day, so that the humidity and temperature increase and the grains get cured. Both in rainfed and irrigated condition, manual harvesting is followed by the farmers.

Manual Harvesting of Finger Millet

Harvesting is generally done in two methods. In the first method, ear heads are harvested with ordinary sickles and straw is cut to the ground. Ear heads are heaped for 3-4 days to cure and then threshed with hand or bullocks. In the second method, the whole plant with ear head is cut, heaped and then threshed. It is estimated that harvesting and threshing of crops consume about one third of the total energy consumed

Finger millet crop was cultivated in the field of Agricultural Engineering College & Research Institute, Kumulur at a spacing of 225 × 100 mm. Nursery seedlings of 25 days age were transplanted manually in well prepared seedbed. Harvesting efficiency for manual harvesting was studied by dividing the field into plots of one square meter. Each plot was harvested manually and the labour requirement and time consumed was studied, simultaneously. The ear heads and the remaining stalk were harvested separately using sickle

The harvesting efficiency for manual harvesting was computed as 98 per cent. The labour requirement for harvesting ear head and stalk separately was recorded as 15-woman days per acre. The cost of harvesting was worked out to be Rs. 4500 per acre at the prevailing wage rate of Rs.300 per labour per day.

Need for Mechanical Harvesting

The total energy used for cultivation of finger millet in rain fed conditions varied from 1892.09 to 2161.45 MJ ha^{-1} (Baath *et al.,* 2018). Seedbed preparation in rain fed crop consumes maximum energy (40.50 per cent) followed by harvest and post-harvest operations (24.36 per cent), weeding and intercultivation (21.90 per cent) ranked third. Harvest and post-harvest operations are the second most energy consuming operations in both rain fed and irrigated crops.

Scarcity of labor and higher wages during harvesting season is a serious problem, which increases the cost of production. Similarly, lack of appropriate machinery is one of the barriers for increasing the production and productivity of finger millet crop. To harvest finger millet, small scale farmers use hand tools, such as scythe or sickle or they use combine harvester which again requires labour for separating the earheads from the stalk (Wekha *et al.,* 2017). Both the techniques are not suitable for small scale-grain production. Harvesting using combine harvester is cumbersome and harvesting using hand tools is time consuming and labour intensive.

Summary and Conclusion

An appropriately scaled machinery is needed for harvesting finger millet cultivated by small scale farmers. Also, introduction of heavier machines has their own constraints like affordability small land holding and limited area of cultivation. These limitations have put the innovations in finger millet cultivation to stand still for a long period of time. Alleviating the above constraints and increasing the area of finger millet production could be possible by the way of mechanization. A suitable tractor operated machine for harvesting of finger millet for harvesting ear heads alone is an immediate need to remove drudgery, reduce losses and increase productivity, reduce turn about time in a two-crop season to avoid weather risk, achieve low cost of harvesting and derive benefit from early marketing of produces.

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Foldscope – A Frugal Microscope to Unfold the Phyllosphere Microbes

Article ID: 12021

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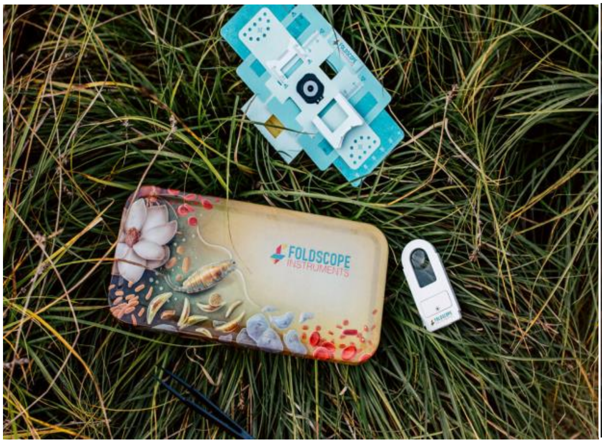
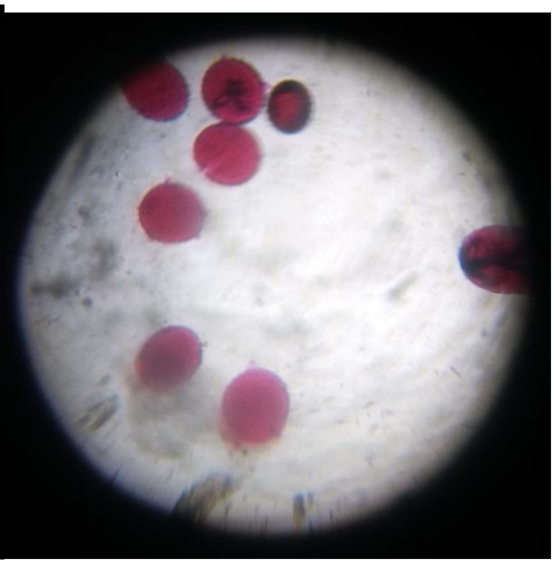
Introduction

The entire world is occupied by the omnipresent microorganisms. They fall under the category of bacteria, fungi, actinomycetes, viruses etc. plants are good inhabitants for a variety of micoorganisms and these microbes' dwell in this excellent niche for food, nutrient, space, water, air, etc. Phyllosphere is the region that surrounds above ground surface of a plant. Most of the microbes have positive and symbiotic interactions with the plants. They communicate with each other to survive in a better way. The only drawback is we cannot visualize these tiny microbes through our human eye otherwise we would be wondering to see them as they do marvellous activities throughout its life cycle. Usually in laboratories microscope is used to view the microorganisms. But it is not user friendly, much fragile and not east to operate also. Here comes the role of Foldscope a frugal microscope that is cheap, user friendly, easy to handle even by a kid. It was invented by Dr. Manu Prakash and his team mates which revolutionized not only the microbial world but also the entire scientific world.





***Aspergillus* conidia viewed under foldscope** **Pollen viewed under foldscope**

Foldscope

Foldscope is a frugal microscope that is portable, versatile, inexpensive, weightless, easy to carry that unfolds the tremendous world of microbes. Foldscope, one dollar microscope was developed by a scientist from Stanford school of Medicine Dr. Manu Prakash and his student Jim in the year 2012. Actually, the idea of creating a low-cost frugal microscope flashed into the mind of Dr. Manu Prakash when he visited a research station at Thailand. Everyone in that station was afraid to handle the microscope and hesitated to bring the microscope to the filed because the microscope what they were using is expensive. At that time Dr. Manu Prakash thought to develop a microscope that is cheap, user-friendly sturdy enough to work in all climates and field situations. His aim was to develop a microscope for every individual and wish that each kid has to carry his own microscope in their book like a book mark. Foldscope is designed in such a way to bring microscopy out of science laboratories and into the hands of each and every one in and around the world. It makes all the individuals irrespective of age, creates curiosity to peep into the microbial world and sparked by pleasant "aha" moments. The feel of that moment should be felt instead of reading them in the books so that a racing heart would know the invisible world. Everyone can visualize water samples, environmental samples, plant samples etc as per their wish even the scrapping of the teeth as did by Anton Von Leeuwenhoek who unravel the beautiful world of microscopic creatures. Now the microscopic invisible world is open to all with a powerful affordable microscope that can fits in the pocket. Curiosity, discovery and science came to the door of everyone make science happen anywhere and at any time!

Many researchers were doing research with the aid of foldscope to observe pathogens, pollens, semen samples, insects, food samples, sewage samples etc. Phyllosphere microorganisms have been isolated from various crops such as rice, pulse and vegetables and were viewed under a frugal microscope known as foldscope. Several novel yeast species were isolated from phyllosphere of rice and observed in foldscope. Drought tolerant bacterial species has been isolated from phyllosphere of rice and the isolates were observed under foldscope.

Phyllosphere

The different above ground portion are found in the phyllosphere regions are caulosphere (stems), the anthosphere (flowers) and the carposphere (fruits). Phyllosphere region has many unique features for microbes. The dorsal and ventral surface of leaf is having complex architecture and epiphytic microbes alter them to have greater access to foods. The presence of microbes in these surfaces has greater alteration ability to safeguard themselves from sunny exposure, ROS formation and oxidative stress.

Microorganisms of Phyllosphere

In the phyllosphere region population of bacteria is higher when compared to fungi and actinomycetes. Bacteria such as *Pseudomonas, Sphingomonas, Methylobacterium*, *Sphingomonads* and *Methylobacteria* are predominant in this region. There are several reports that the above ground part microbes stimulate the plant growth, disease resistant and stress tolerance. The fungal species typically present in the phyllosphere region is *Aureobasidium*, *Cladosporium*, and *Taphrina* are common and the yeasts such as *Basidiomycetous* and *Sporobolomyces* are occupied rich in phyllosphere. Some genus like *Mycosphaerella, Devriesia, Sphaceloma Ramularia, Stenella, Paraphaeosphaeria, Dioszegia, and haeosphaeria,* were more in the oak trees. Yeast population was also prevalent in the phyllosphere and the genus such as *Rhodotorula, Candida, Saitonyma* are commonly observed in the phyllosphere region.

Role of Phyllosphere Microbes

The phyllosphere microbes have ability to produce the plant growth promoting hormones namely auxin, cytokinins and Gibberellins that are needed for plant growth. Phyllosphere *Methylobacterium* secretes enzyme called 1-aminocyclopropane-1-carboxylate (ACC) deaminase that decreases the level of stress response hormone ethylene in the plant species. Moreover *Pseudomonas* spp., *Arthrobacter* spp. and *Bacillus* spp. are enhancing the plant growth by the production of ACC deaminase. Phyllosphere microbes were known to produce antibiotics that inhibit the growth of pathogens. They also involved in Phylloremediation or Folioremediation to degrade the toxic compounds to plants, humans and environment.

Factors Affecting Phyllosphere Microbiota

Several environmental factors influence the presence of microorganisms in the phyllosphere. The abiotic factors include water, moisture, presence of salt, wind, and fluctuations in temperature. These factors affect the interactions of microorganisms with plants. Epiphytic microbes are also able to tolerate various stress conditions including UV-light, high temperature, osmotic stress and low humidity varied throughout day leads to strong impact on community composition on epiphytic microbe. The Pigment producing bacteria in the phyllosphere are *Pseudomonas, Methylobacterium* and *Sphingomonas*, is protecting themselves against UV radiation. Extracellular sugars caused cell aggregation and protects phyllosphere organism from drought and osmotic stress.

Conclusion

Many works were carried out in the rhizosphere and phyllosphere region. When compared to rhizosphere region, phyllosphere microbes face more challenges in nutrient acquisition as it has to obtain its nutrient from the surface of leaf and also from the atmosphere. There is a wide opportunity to knock the phyllosphere microbial world and its role over crop production. Usage of foldscope can also be magnified to get optimum usage out of this useful tool. Each and every kid has to keep this foldscope in his book as a bookmark so that he or she can see the things that couldn't be viewed by human eye.

Acknowledgement

Authors acknowledge Department of Biotechnology (DBT), Ministry of Science and Technology, Government of India, and Foldscope Instruments Inc., Prakash Lab (Stanford) for funding the project and providing Foldscope received under the program "Proposals for the use of Foldscope as a research tool".

AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Role of Silica Nanoparticles in Agriculture

Article ID: 12022

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Introduction

The entire world is occupied by the omnipresent microorganisms. They fall under the category of bacteria, fungi, actinomycetes, viruses etc. plants are good inhabitants for a variety of micoorganisms and these microbes' dwell in this excellent niche for food, nutrient, space, water, air, etc. Phyllosphere is the region that surrounds above ground surface of a plant. Most of the microbes have positive and symbiotic interactions with the plants. They communicate with each other to survive in a better way. The only drawback is we cannot visualize these tiny microbes through our human eye otherwise we would be wondering to see them as they do marvellous activities throughout its life cycle. Usually in laboratories microscope is used to view the microorganisms. But it is not user friendly, much fragile and not east to operate also. Here comes the role of Foldscope a frugal microscope that is cheap, user friendly, easy to handle even by a kid. It was invented by Dr. Manu Prakash and his team mates which revolutionized not only the microbial world but also the entire scientific world.

Direct Impact of Silicon Nanoparticles on Plants

The response of plants to nanoparticles depends on various factors, including the size, shape, method of application, chemical properties, and physical properties of the nanoparticles. Si-NPs may directly interact with plants and impact their morphology and physiology in various ways, including the addition of structural color to the plants, help in improving plant growth and yield. Silicon nanoparticles were observed to form a binary film at the epidermal cell wall after absorption, which may add structural color to plants. The impact was not limited to coloring; Si-NPs were also speculated to act as a strengthening material that may act as an agent to prevent fungal, bacterial, and nematodal infections and, thus, may increase disease resistance.

Use of Silicon Nanoparticles (Si-NPs) in Agriculture

The unique physiochemical properties of nanoscale silicon particles have useful applications in different sectors, including promising applications in the agricultural sector. The unique properties of Si-NPs allow them to cope with agricultural damage that may occur through climate change or abiotic stress. The application of Si-NPs in agriculture may also lead to global food security by helping in the development of improved varieties with high productivity. In the agricultural sector, Si-NPs were observed to be applied as a weapon against heavy metal toxicity, UVB stress, and salinity stress. Moreover, additional novel applications of Si-NPs include their use as fertilizers, pesticides, and herbicides. Therefore, Si-NPs have the potential to improve crops for sustainable agriculture.

Silicon Nanoparticles as Pesticides

In the present decade, nanotechnology has intervened in helping develop disease-free agricultural crops. Under the large umbrella of nanotechnology, nanosilica, a unique type of nanomaterial, is used as a nanopesticide. Si-NPs have been observed to be used in two ways: either Si-NPs were directly applied in the field and played the role of pesticides, killing insects and larvae, or mesoporous silica nanoparticles were used as nanocarriers that released commercial pesticides to enhance their efficiency. It was shown that SiO_2 NPs had lethal properties for *Callosobruchus maculatus*; it was observed that the nanoparticles were more effective on adult insects than larvae, and it was speculated that the impact could be due to dehydrating properties of silica, which may result in impairment of the digestive tract or surface enlargement of the integument. The lethal impact of Si-NPs for pests can also be due to blockage of spiracles and tracheas or damage to the protective wax coating on the cuticle by sorption and abrasion.

Silicon Nanoparticles (Si-NPs) as Delivering Agent for Herbicides and Fertilizers

Due to the unique physical and chemical properties of silicon nanoparticles, they can easily enter into plant cells and affect the plant growth and development by affecting their metabolism through diverse interactions, thereby triggering the potential to combat stress conditions. In the present scenario, where the focus is to increase crop productivity or to eradicate weeds, Si-NPs may act as an agent for target-specific delivery of herbicides and fertilizers. Silicon nanocarriers have been observed to carry herbicides (chloroacetanilide, anilide, and benzimidazole) embedded in a diatom fistule and deliver the herbicide to the field in its active form. In the case of fertilizer delivery, studies signified that the application of nano-silicon dioxide with organic fertilizer was used to improve plant productivity. Mesoporous silica nanoparticles (MSNs) with a specific pore size (2–10 nm) served as an efficient delivery vector for urea-, boron-, and nitrogenous-based fertilizers. Thus, Si-NPs have the potential to be used as a fertilizer alone for specific crops and can be used to deliver herbicides and fertilizers in plants.

Si-NPs in Target Delivery of Protein, Nucleotides and Chemicals in Plant

The implementation of several nanoplatforms in various fields under in vitro conditions has spawned concerns in agri-nanotechnology. This technology embraces the promise of controlled and regulated release of agrochemicals and site-targeted delivery of various macromolecules, such as proteins, nucleotides, and chemicals, for improved plant resistance and nutrient efficiency, as well as increased crop yields. Nanoencapsulation has demonstrated the efficient and protected use of chemicals with less release to the environment and ensures eco-protection. The uptake, competence, and impact of various nanoparticles on plant growth, development, and biochemical process vary diversely among various plant species. Specifically, the use of MSNs in targeted delivery of various chemicals provides new insight into the safe use of this novel technology for improving crop variety and yield.

Mesoporous Silicon Nanoparticles (MSNs)

Mesoporous silicon nanoparticles (MSNs) have chemically and thermally stable structures with large surface areas, tunable pore sizes, and several well-characterized surface properties, which makes them suitable for hosting guest molecules. In addition, the size-adjustable 3D open pore structure allows the regulation of adsorption rates to create effective delivery carriers.

Surface-Coated MSNs

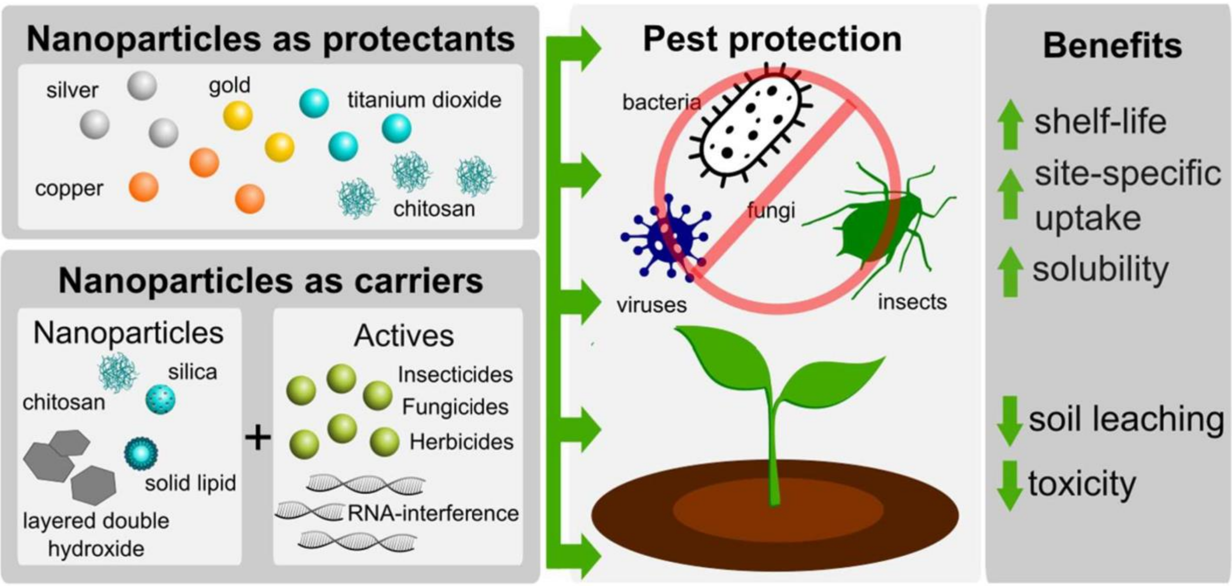
Surface-coated MSNs were useful for DNA and SiRNA delivery due to their binding affinity and high cellular uptake. Demonstrated the transportation of DNA and chemicals (with the gene and its chemical inducer) into isolated plant cells and intact leaves through MSNs. The direct delivery of a Cre recombinase protein through gold-plated MSNs was also successfully achieved by a biolistic method in maize. Therefore, MSNPs have become established as transportation materials and have the potential to be used for the development of genetically modified crops.

Si-NPs as a Component of Nanozeolites for the Purpose of Increasing Water Holding Capacity

Soil is the most essential factor that regulates plant growth by controlling nutrient and water reserves; therefore, improved soil quality is vital for increasing crop productivity Natural zeolites are an important alternative to overcome the effects of drought in arid regions. Considering the increasing interest in this area, various nanosized zeolites have been prepared and used to improve soil quality, as well as the impacts of chemical and organic fertilizers, for crop improvement .To combat negative hydric impacts in soil, nanozeolites act as a slow-release source for water and, therefore, increase the water holding capacity of the soil reported the effect of the application of nanozeolite and zeolite on the water-stable mean weight diameter (MWDw), which is an index of aggregation, stability and strength as well as the aggregate size fraction of carbon. The aggregation process plays a substantial role in improving soil physical characteristics, such as water conduction, infiltration, and ventilation. These zeolites and nanozeolites facilitate water infiltration and retention in the soil due to their porous and capillary properties. Zeolites are known to act as natural wetting agents and work as water distributors throughout the soil, ultimately affecting water conduction in plants. Thus, the observed results clearly showed the ability of Si-NPs to enhance the water holding capacity and, therefore, improve soil quality.

Conclusion

Nanotechnology is a promising area of interdisciplinary research that opens avenues in several fields, such as medicine, pharmaceuticals, electronics, and agriculture. This article presents the potential of Si-NPs in agriculture and brings together the literature relevant to the use of nanoparticles as pesticides, fertilizers, herbicides, genetic and drug transfer agents, soil improving agents, and sensors for soil analysis. Studies show that Si-NPs have the potential to revolutionize the existing technology used in various sectors, such as agriculture and plant biotechnology. Silicon nanoparticle-mediated targeting of biomolecules would be useful for developing new cultivars that are resistant to various biotic and abiotic factors. These nanoparticles can provide green and eco-friendly alternatives to various chemical fertilizers without harming nature. Thus, Si-NPs may have concrete solutions to many agricultural problems regarding weeds, pathogenicity, drought, crop yield, and productivity.



Integrated Input Management in Rainfed Agro-Ecosystems

Article ID: 12023

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Rainfed agro-ecosystem that un-touched by green revolution, occupies a very important position in the Indian agriculture. The rainfed agro-ecosystem having annual rainfall from 500-1500 mm constitutes 67 per cent of the net cultivated area in the country. Rainfed agriculture supports 40 per cent of the India's population and contributes 44 per cent to the national food basket. It accounts for nearly 70 per cent of the oilseeds, 90 per cent of the pulses and 70 per cent of the cotton. The per capita land availability in rainfed areas is expected to come down from 0.28 ha in 1990 to 0.12 ha by 2020 (CRIDA, Vision 2020). The demand for food would continue to rise necessitating higher productivity from rainfed regions (2 Mg ha^{-1}) which emphasizes the critical importance of rainfed agriculture in Indian economy and food security of the growing population. Rainwater, the most crucial input must be harvested properly either in-situ through land configuration, tillage, mulching etc. or ex-situ through watershed management and should be used in most efficient manner. The nutrient use efficiency in this agro-ecosystem should be improved through optimizing the nutrient levels with the limited availability of water, and by following integrated plant nutrient supply system.

Distribution of Rainfed Agro-Ecosystem

In India over 97 million hectares of the cultivated area are under rainfed agriculture. The arid region of India constitutes 12 per cent of the total geographical area and spread over 7 states out of which 80 per cent area comes within the boundary of two states namely Rajasthan and Gujarat. The dry semiarid region is spread over 12 per cent of the TGA of the country and receives mean annual rainfall of 750 to 1100 mm with a growing season of 75 to 100 days. The wet semi-arid region constitutes 25.9 per cent of the TGA and has a growing period of 120 to 150 days. The dry sub humid region constitutes 21.1 per cent of the TGA and is mainly distributed in the central highlands, Deccan Plateau, Eastern Plateau and Eastern Ghats region.

Table 1. Conventional classification of rain-fed agro-ecosystems based on moisture index:

Climate zone	Mean annual rainfall (mm)	Moisture index (%)
Arid	< 500	-80.0 to -66.7
Semi-arid (dry)	501 – 700	-66.6 to -50.6
Semi-arid (moist)	701 – 1000	-50.5 to -33.3
Sub – humid (dry)	1001 – 1600	-33.3 to 0.0

Constraints of Rainfed Agro-Ecosystem

Rainfed agriculture suffers from a number of bio-physical and socio-economic constraints which limit the productivity of crops viz., erratic and undependable rainfall, excess and deficient of moisture within the same season, harsh thermal regime, land degradation and poor productivity, low level of input use, low level of technology adoption and resource poor farmers. Beside these constraints, the soils in the rainfed region suffer from various other constraints that limit crop production potential. While some constraints arise due to the nature and properties of soil, some others get multiplied by the degradation processes viz., soil erosion by water and wind, nutrient depletion by crops, salinization due to irrigation and compaction/hard setting.

Strategies for Rainfed Agro-Ecosystem Management through Integrated Input

1. Efficient Management of Rainwater: Rainwater is an important the key input in dryland agriculture. The annual rainfall in the rain-fed region of the country is quite erratic with large spatial and temporal variation. It is about 20 per cent in dry sub-hu mid region but in the arid rainfed region it is as high as 61 per cent. Of the total annual rainfall in the rainfed agro-climatic region more than 80 per cent is received in just four months from June to September through south-west monsoon, which nurtures more than 90 per cent of rainfed agriculture of the country. So, the fate of a major area of rainfed agriculture oscillates with the extent of aberrations in south-west monsoonal rainfall. Thus, in a tropical country such as India, which experiences extreme variation in rainfall, both in space and time, rainwater management assumes vital importance in minimizing the risks and stabilizing crop production in dry areas.

Water harvesting is an age-old practice in India. It is a process of collection of ran-off water from treated or untreated land surfaces/ catchments or roof tops and storing it in an open farm pond or closed water tanks/ reservoirs or in the soil itself (in-situ moisture storage) for irrigation purposes.

2. In-situ Rainwater Conservation: The strategy for in situ moisture conservation lies in soil management, which aims at maximizing the use of rainfall by increasing infiltration and storage. This can be achieved with the help of deep ploughing, profile modification, vertical mulching or by keeping the soil surface rough. The in-situ rainwater harvesting techniques are location specific and depend on the rainfall intensity slope and texture of the soil (Acharya and Hati 2002). On lands having slope up to 1 to 2 per cent, field bunding, and leveling, contour ditching or cultivation along contour can ensure water conservation. On lands having 2 to 6 per cent slope, graded contour bunds can be constructed to conserve water in the profile and check runoff and soil losses (Singh 2000). In-situ rainwater conservation can be carried out either through land configuration or adoption of suitable tillage practices or through mulching.

3. Land configuration: Some of the efficient land management techniques for rainfed agro-ecological regions, which encourage surface drainage and recharge of soil profile with rainwater and reduces runoff and soil erosion are discussed below:

a. Raise and sunken bed:
b. Ridge and furrow systems:
c. Tied ridging:
d. Compartmental bunding
e. Broad bed and furrow (BBF) system.
f. Bench terracing.
g. Modified contour bund system.

4. Adoption of Suitable Tillage Practices: Tillage has a marked influence on the conservation of soil and rainwater. Tillage makes the soil surface more permeable and thus, supports water intake. Some important tillage practices recommended for conservation of rainwater are as follows:

a. Deep tillage.
b. Summer ploughing or off-season tillage.
c. Conservation tillage.
d. Mulching.

5. Ex-situ Rainwater Harvesting and Its Efficient Recycling: Besides *in-situ* water conservation, water harvesting in natural or man-made structures is a potential means of providing water for crop production in rainfed areas. The main aim of water harvesting is to make crop production economically feasible in regions where rainfall is normally insufficient for cropping even with the best water conservation measures. Chittaranjan *et al.* (1996) reported that in the black soil region under semi-arid condition 40 mm of the annual rainfall of 500 mm can be harvested into dug out ponds, which can be used for supplemental irrigation. The runoff harvesting, storage and utilization involves, selection of catchments, selection of site and estimation of size of farm pond based on rainfall and catchment area, construction of farm pond, laying of silt trap and spill ways, minimization of seepage, percolation and evaporation losses from the pond and utilization of stored water for life saving irrigation of kharif crop or for establishment of rabi crops in the catchment.

The different ex-situ rainwater harvesting technologies include roof top collection, dug out ponds, storage tanks, nala bunding, gully control structures, check dams, percolation tanks, subsurface dams *etc.* The ex-situ rain-fall harvesting technology is highly location specific and practices evolved in a given region have limited application in other regions.

Precision Farming Tools in Agriculture

Article ID: 12024

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Precision Farming

The term Precision Farming means the application of technologies and principles to manage spatial and temporal variability associated with all aspects of agricultural production for improving crop performance and environment quality by using satellite, sensors and field maps. Precision Farming means the process by which exact or accurate results of farming can be obtained.

Precision farming is defined as a site specific, information and technology-based farm management system to identify, analyse and manage variability within fields for optimum profitability, sustainability and protection of the land resources. (Singh, 2008).

Concept of Precision Farming

Better yield management decisions that will lead to higher productivity, high profit by reduced cost of cultivation and reduced environmental impact because of the reduced input addition to the soil.

Objectives of Precision Farming

1. Increased Production Efficiency.
2. More Efficient Input Usages.
3. Improved Product Quality.
4. Energy Conservation.
5. Soil and Ground Water Conservation.

Need for Precision Farming in Indian Agriculture/ Allied Sectors

1. Increased Land Degradation
2. Depletion of Water resources.
3. Socio economic need for enhanced productivity / unit of land, water and time.
4. Environment Pollution because of increased use of fertilizers and chemicals.
5. PF is essential in order to address poverty alleviation, enhance quality of life and food security
6. Indian agriculture system facing a lot of problems which leads to lower productivity of crops, hence there is a need to adopt precision farming techniques to reduce the variability which inturn helps to increase the productivity.

Steps in Precision Farming

It is a cyclic process but farmer needs to perform annual planning, data collection and analysing various steps to complete the precision cycle.

1. Assessing variability: Inputs are to be applied in accordance with existing variability using GPS, GIS, RS, YM etc….

2. Managing variability: by applying and making farm inputs available only in required quantities at particular time and specific location known as Variable Rate Application (VRA).

3. Evaluation of precision farming:

a. Economic viability focuses on market return through sale of the produce
b. Maintenance of environment focus on PF can improve soil, water and crop environment.
c. Finally how far this technology can be transferred to other farmers.

Components of Precision Farming

1. Global Positioning System (GPS).
2. Variable rate applicator (VRA).

3. Yield mapping.
4. Geographic Information System (GIS).
5. Remote sensors.
6. Proximate sensors.
7. Computer hardware & software.
8. Precision Farming Practices.
9. Technology Dissemination.

Global Positioning System

1. It is a network of satellites developed for and managed by the U.S. Défense Department.
2. The GPS are important to find out the exact location in the field to assess the spatial variability and site-specific application of inputs.
3. The most common use of GPS in agriculture is for yield mapping and variable rate fertilizer/pesticide application.

Application of GPS in Precision Farming

1. Controlled application of inputs by equipment's.
2. Identification the precise location of farm equipment's within inches (or 5 cm).
3. One can monitor and record the yield data of the field.
4. Fertilizers and pesticides can be prescribed according to the soil properties, soil condition.
5. Tillage adjustment can be made as one finds various condition.

Geographic Information System (GIS)

Geographic Information System (GIS) is a computer-based management system used for computation, storage, retrieval, analysis and display of spatial data in the form of a map.

GIS Contributes Significantly to Precision Farming

1. It contains base maps like topography, soil type, nutrient level, soil moisture, pH, fertility, weed and pest intensity maps *etc.*
2. It can integrate all types of information and interface with other decision support tools.
3. So these maps and information are used for application of recommended rates of nutrients or pesticides.

Variable Rate Technology

1. Variable Rate Technology (VRT) includes computer controllers that allow variation of inputs such as seed, fertilizer, herbicides and pesticides.
2. Application rates are varied as areas of different problems warranting different rates are encountered.

Yield Maps

Yield maps are produced by processing data from adapted combine harvester that is equipped with a GPS i.e., integrated with a yield recording system. Yield mapping involves the recording of the grain flow through the combine harvester, while recording the actual location in the field at the same time.

Precision Farming Practices

1. Micro Propagation.
2. Micro Irrigation.
3. Drip Irrigation.
4. Fertigation.
5. Mulching.
6. Protected Cultivation.
7. Pruning.
8. Direct Seeding / Transplanting.
9. Mechanization.
10. Use of modified crop varieties.
11. Hitech post-harvest handling.

Limitation of Adopting PF Under Indian Conditions

1. Small farm size.
2. Heterogeneity of cropping systems.
3. High cost of obtaining site specific data.
4. Complexity of tools and techniques requiring new skills.
5. High initial investment.
6. Infrastructure and institutional constraints.
7. Lack of local technical expertise (*India spends only 0.3% of its agricultural GDP in Research and Development).*
8. PF as new story to Indian farmers needs demonstrated impacts on yields.
9. Knowledge and technical gaps.

Research & Development Activities on PF in India

1. Space Application Center, ISRO, Ahmedabad in collaboration with CPRI, Shimla, has initiated a study on exploring the role RS for precision farming in the CPRS farm at Jalahandhar, Punjab.
2. M S Swaminathan Research Foundation, Chennai, in collaboration with NABARD, has adopted a village in Dindigul district of Tamil Nadu for variable rate input application.
3. IARI has drawn up a plan to do precision farming experiments in the institutes' farm.
4. PDCSR, Modipuram and Meerut (UP) in collaboration with Central Institute of Agricultural Engineering (CIAE), Bhopal also initiated variable rate input application in different cropping systems.
5. In coming few years precision farming may help the Indian farmers to harvest the fruits of frontier technologies without compromising the quality of land.

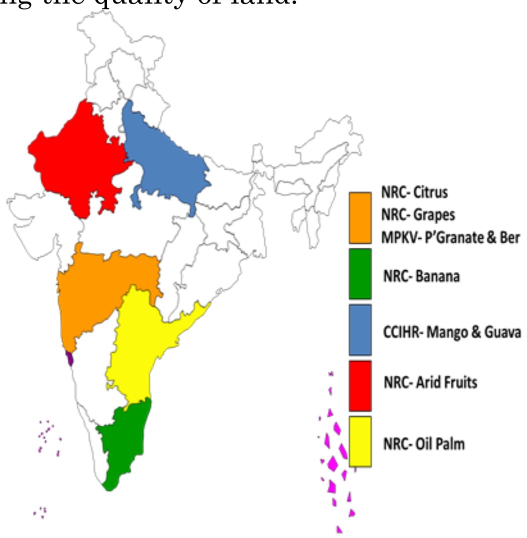

Fig. 1. Precision Farming Development Centers in Fruit Crops

AGRICULTURE & FOOD: E-NEWSLETTER
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E-ISSN: 2581 - 8317

Methane Emissions from Rice Fields and its Mitigation Options

Article ID: 12025

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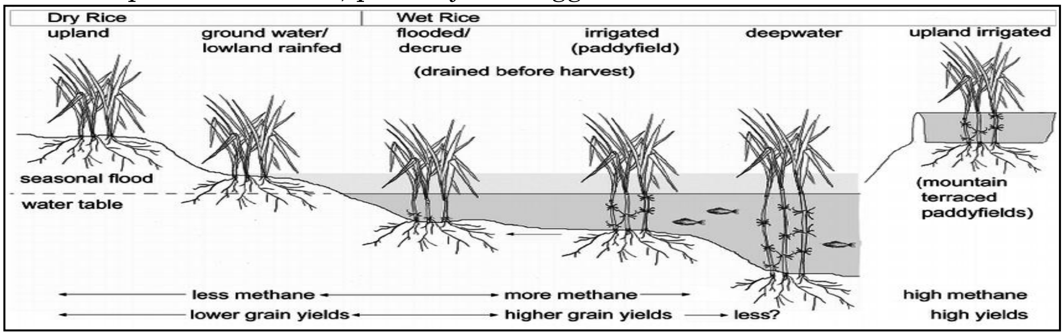
The increasing demand of the growing population requires enhancement in the production of rice. This has a direct bearing on the global environment since the rice cultivation is one of the major contributors to the methane emissions. As the rice cultivation is intensified with the current practices and technologies, the methane fluxes from paddy fields are substantially rising. Improved high yielding rice varieties together with efficient cultivation techniques will certainly contribute to the curtailment of the methane emission fluxes. Irrigated rice farming in paddy fields is an important source of Methane (CH_4).

Methane is a chemical compound with the chemical formula CH_4. It is the simplest alkane and the main component of natural gas. The relative abundance of methane makes it an attractive fuel. Rice agriculture is a big source of atmospheric methane, possibly the biggest of man-made methane sources.



Flooded Rice Fields

In flooded rice field, anaerobic decomposition of organic material results in production of produces methane (CH_4). This gas later escapes to the atmosphere primarily by diffusive transport through the rice plants during the growing season. From the wide sources of atmospheric CH_4, rice paddy fields are considered one of the most important.

Methane Production Processes

1. Flooded rice fields are a significant source of atmospheric CH_4.
2. The emission is the net result of opposing bacterial processes, production in anaerobic microenvironments, and consumption and oxidation in aerobic microenvironments, both of which can be found side by side in flooded rice soils.
3. The major pathways of CH_4 (methane) production in flooded soils are the reduction of CO_2 (carbon dioxide) with H_2 (hydrogen).

$$CO_2 + 4\ H_2 \rightarrow CH_4 + 2H_2O$$

Methanogenesis

1. Naturally occurring methane is mainly produced by the process of methanogenesis. This multistep process which is used by microorganisms as an energy source. The net reaction is:

$$CO_2 + 8\ H^+ + 8e^- \rightarrow CH_4 + 2\ H_2O$$

2. Also referred to as biomethanation
3. It is the formation of methane by a group of microbes called methanogenic bacteria
4. Methane is produced as a terminal step of the anaerobic breakdown of organic matter and is exclusively produced only in the strict absence of free oxygen. Methanogens rely on a plethora of other microorganisms

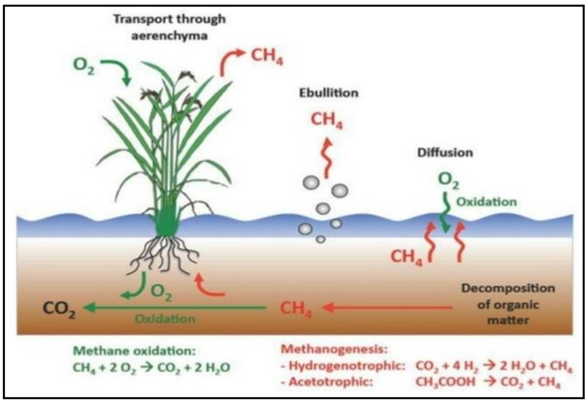
to provide them with the few substrates they can catabolize: hydrogen, CO_2, formate, acetate, methanol, methylamines, and methysulfides

5. Application of fertilizer, especially organic manure and submergence with deep water increased the population and methanogenic activities of methanogenic bacteria in rice soils.
6. This process is estimated to contribute about 25% of the total budget of global methane emissions.

Processes Involved in Methane Emissions

Methane emissions from rice paddy result from these processes:

1. A concentration gradient that causes diffusion through the soil-water and water-air interfaces.
2. The release of gas bubbles from soil surface to the atmosphere.
3. Soil methane enter into the plant through the roots, is released to the atmosphere through the plant stomata.



Factors Affecting Methane Emission

1. Land preparation.
2. Rice varieties.
3. Water management or Water table.
4. Soil texture.
5. Agricultural practices.
6. Microorganisms.
7. Seed preparation.
8. Fertilizer application.
9. Harvesting and fallow period.
10. Climate.
11. Organic matter.
12. Plant growth stage.

Mitigation of Rice Cultivation Related Methane Emission

Methane mitigation opportunities within the rice cultivation sector include:

1. Water management (Temporary drainage of rice fields):

a. Altering water management, in particular promoting midseason aeration by short-term drainage, is one of the most promising strategies, although these practices may be limited to the rice paddy fields where the irrigation system is well prepared. This method reduces methane production.

b. Shifting drainage time from vegetative period to reproductive period help reduce methane production and emission.

c. Shorten drainage day also help reduce methane emission.

2. Reduce use of organic matter:

a. Improving organic matter management by promoting aerobic degradation through composting or incorporating into soil during off-season drained period.

b. Reduce the use of organic matter or organic manure in rice fields (wet lands). Use inorganic fertilizer to increase the yields in wet lands.

3. Dry land rice cultivation:

a. Many rice varieties can be grown under much drier conditions than those traditionally grown, with big reductions on methane emission without any loss in yield.

b. Additionally, there is the great potential for improved varieties of rice, able to produce a much larger crop per area of rice paddy and so allow for a cut in the area of rice paddies, without a cut in rice production.

4. Application of ammonium sulphate: The addition of compounds such as ammonium sulphate, which favours activity of other microbial groups over that of the methanogens.

5. A soil conditioner:

a. Is a product which is added to soil to improve the soil's physical qualities, especially its ability to provide nutrition for plants. It is category of soil Amendments which more often include a wide range of fertilizers and non-organic materials.

b. Soil conditioners can be used to improve poor soils, or to rebuild soils which have been damaged by improper management.

c. They can make poor soils more usable, and can be used to maintain soils in peak condition.

d. A wide variety of materials have been described as soil conditioners due to their ability to improve soil quality. Some examples include: bone meal, peat, coffee grounds, compost, manure, straw, vermiculite, sulfur, lime, blood meal, compost tea, hydroabsorbant polymers and sphagnum moss.

Conclusion

Interdisciplinary research approach, including application of socioeconomics and participation of farmers, to achieve the knowledge needed to design feasible and effective mitigation technologies.

The opportunity to reduce methane emissions should not outweigh the need to feed a growing population. With current cultivation technologies, methane emission from rice fields is expected to increase, as rice production is increased by 50 to 100% within the next three decades.

By using a combination of feasible mitigation technologies, however, there is great potential to stabilize or even reduce methane emission from rice fields while increasing rice production, without dramatically changing culture practices.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Technology Trends in Modern Agriculture

Article ID: 12026

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Over the last 50 years, the agriculture industry has witnessed radical changes. Technological advancements in farm machinery led to increased productivity of farm equipment allowing efficient cultivation of available land and also in extending the cultivation. Past advances were mostly mechanical, in the form of more powerful and efficient machinery, and genetic, in the form of more productive seed and fertilizers. Now much more sophisticated, digital tools are needed to deliver the next productivity leap. In terms of adopting new technologies, the agriculture industry continues to lag behind all other industries. In order to cope with rising demand and a slew of disruptive forces, agrisector must embrace a digital, connectivity-fueled transition. A technology revolution has resulted in new agricultural inventions that will alter the agricultural landscape. Some of these technologies which have the potential are mentioned below.

Emerging Agricultural Technology Trends

1. Automation: Farmers frequently have to deal with repeated activities in the field, and this work is mostly labor-intensive. Agriculture is an ideal sector for robotics developments. Agricultural robots now perform a wide range of functions, including sowing, watering, harvesting, and so on.

a. Robotics and geomapping are used in autonomous precision seeding. The soil attributes (quality, density, etc.) at each position in the field are plotted on a map. The seeds are then placed at precise positions and depths by the tractor's robotic seeding attachment, ensuring that each has the highest chance of germinating.

b. By irrigating plants with robot-assisted precision irrigation, the amount of water lost is reduced. Ground robots navigate between rows of crops on their own, pouring water directly at the roots of each plant.

c. Computer vision technology is used by micro-spraying robots to detect weeds and then spray a targeted drop of pesticide onto them. Microspraying could drastically reduce the amount of pesticide/weedicide used in agricultural production.

d. Autonomous tractors are driver less tractors that rely on current technology to increase efficiency and reduce human interference.

2. Internet of Things (IoT) in Agriculture: Various sensors implanted in the agricultural farm enable the usage of the Internet of Things in intelligent farming. Light, humidity, soil moisture, temperature, crop health monitoring, and other sensors are used. Following are some use cases of IoT in agriculture.

a. Drones for irrigation, crop health assessment, spraying, monitoring, and field analysis from the air and on the ground.

b. Rainfall, temperature, soil, humidity, and other variables are all subject to predictive analytics.

c. With the help of IoT devices and sensors, an innovative greenhouse has been created that does not require human interaction.

d. Image processing paired with machine learning compares photographs from the database to images of crops to determine size, shape, colour, and growth, and adjusts the grade as a result.

3. Geographic Information System (GIS) in agriculture: Farmers can use GIS to examine complicated spatial data such as rainfall amount, topography, soil elevation, slope aspect, wind direction, flooding, erosion, and so much more in the agricultural domain. Several satellites have already been launched by the government or universal agencies, and access to a particular geographic data requires payment of a charge. Crop yield prediction, crop health monitoring, insect and pest control, irrigation control, flooding, erosion, and drought control, farming automation are some of the applications of GIS in agriculture.

a. GIS can assess soil data and past agricultural practices to decide the best crops to sow, where they should be planted, and how to keep soil nutrition levels at optimal levels for the plants.

b. Manually inspecting crop health across numerous acres is the least efficient method. This is where remote sensing in conjunction with GIS in agriculture can help.
c. GIS in agriculture can be used to help prevent, assess, and reduce the harmful effects of natural disasters.

4. Artificial Intelligence/ Machine learning & Data Science in Agriculture: Agriculture's complete life cycle includes soil preparation, seed sowing, fertilizer application, irrigation, weed control, harvesting, and storage. Growers/ farmers must rely on their perceptions, predictions, and risks based on other elements at every stage of the process. AI and machine learning can make a significant contribution and profit from their proven data analysis and forecasts. Data science processes and channels all of the critical agricultural data collected by IoT devices and ML algorithms. Farmers are unable to use raw data, therefore data science is revolutionizing the way they make critical decisions.

5. Block chain: The importance of block chain in replacing traditional means of storing, sorting, and distributing agricultural data into a more trustworthy, immutable, transparent, and decentralized manner is critical. In precision farming, the Internet of Things and block chain will transform us from having merely smart farms to having an internet of smart farms, giving us more control over supply-chain networks. As a result of this combo, precision agriculture will be managed with more autonomy and intelligence in a more efficient and optimum manner. Advantages of blockchain in agricultural value chain:
a. Ensure that agricultural products are traceable from farm to fork.
b. Ensure that data is stored, fielded, and distributed in a temper-proof manner.
c. Removes middlemen and keep market prices under control.
d. Smart Contracts provide more control over the process.
e. Finally, a secure environment with blockchain implementation for improved data security.

Technologies aid in the production of healthy crops, management of pests, monitoring of soil, and development of a variety of farming-related jobs. These disruptive trends will help the industry overcome its obstacles. The above-mentioned trends are not the only technological innovations that will change the future of modern agriculture. Of course, these innovations along with other practices will definitely design the landscape of agriculture.

AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Electrolytes: Important to Stay Healthy

Article ID: 12027

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Introduction

Electrolytes are minerals found in bodily fluids that carry an electric charge and are essential to keeping the heart, nerves and muscles functioning properly. The kidneys play an important role in ensuring that electrolyte levels remain invariant despite any changes the body may undergo. Having an excess or an insufficiency of electrolytes in the body can be dangerous and, in some cases, fatal.

One of the major roles of electrolytes is to ensure that fluid levels inside and outside the cell is balanced. The cell can adjust its fluid levels by changing the concentration of electrolytes. For example, an increase in electrolytes within the cell draws more fluid in whereas a decrease in electrolytes promotes an efflux of fluids. Sustaining this type of osmotic gradient is essential for nerve and muscle function, hydration, and maintaining blood pH levels. Additionally, electrolytes carry electrical impulses across the cell and to neighbouring cells in order to promote muscle contractions and nerve impulses.

The most common electrolytes found in the body are calcium, sodium, potassium, phosphate, chloride and magnesium. The serum values and individual functions for these electrolytes are:

a. Sodium is the major cation (positively charged ion) found outside the cell. It regulates the total amount of water in the body and plays a major role in neuronal and nerve signaling. Normal serum sodium values range from 135 -145 milliequivalent/liter (mEq/L).

b. Potassium is the major cation inside the cell. Potassium is essential for the proper functioning of the heart, kidneys, muscles, nerves, and digestive system. The normal blood potassium level is 3.5 -5.0 mEq/L.

c. Chloride is the major anion (negatively charged ions) found outside the cell. Chloride plays a critical role in keeping the proper balance of body fluids and maintaining the body's acid-base balance. The normal chloride values are 96-106 mEq/L.

Electrolyte Imbalance

An electrolyte imbalance can develop as a result of either having excess or a deficiency of electrolytes in the body. An electrolyte imbalance may be caused by:

1. Loss of body fluids: may be caused by prolonged vomiting, diarrhoea, sweating or high fever.
2. Poor diet.
3. Malabsorption: the body may be unable to absorb electrolytes due to a variety of stomach disorders.
4. Hormonal or endocrine disorders.
5. Kidney disease.
6. Certain medications: chemotherapy drugs, diuretics, antibiotics, and corticosteroids.

A majority of the electrolyte related health problems occur when levels of sodium, potassium or calcium are unbalanced. Hypernatremia (having an excess of sodium) is the most common type of electrolyte imbalance.

Symptoms of Electrolyte Imbalance

Symptoms will depend on which electrolyte is out of balance and whether the level of that substance is too high or too low. A harmful concentration of magnesium, sodium, potassium, or calcium can produce one or more of the following symptoms:

1. Irregular heartbeat.
2. Weakness.
3. Bone disorders.
4. Twitching.
5. Changes in blood pressure.

6. Confusion.
7. Seizures.
8. Numbness.
9. Nervous system disorders.
10. Excessive fatigue.
11. Convulsions.
12. Muscle spasm.

Treatment of an Electrolyte Imbalance

Treatment of electrolyte imbalance may vary depending on the underlying cause or which electrolyte is imbalanced. Treatments include:
1. Intravenous fluids.
2. Dietary changes. Minor electrolyte imbalances may be remedied by dietary changes. For example, consuming more potatoes, bananas or avocados will increase potassium levels. Eating more leafy green vegetables will increase magnesium levels. Increasing the intake of celery and yogurt will increase sodium and calcium levels, respectively.

In order to stay healthy, it is critical to replace electrolytes lost through sweat or as a result of a poor diet. A diet that includes whole grains, leafy greens, fresh fruits and vegetables usually provides the electrolytes for body needs. It is also important to supplement diet with sports drinks or fruit juices when participating in strenuous activity.

Monitoring

An electrolyte panel is used to screen for imbalances of electrolytes in the blood and measure acid-base balance and kidney function. This test can also monitor the progress of treatment relating to a known imbalance. Levels are measured in millimoles per liter (mmol/L) using the concentration of electrolytes in the blood. If the level of a single electrolyte is found to be either too high or too low, the doctor will keep testing this imbalance until levels are back to normal. If an acid-base imbalance is found, the doctor may carry out blood gas tests. These measure the acidity, oxygen, and carbon dioxide levels in a sample of blood from an artery. They also determine the severity of the imbalance and how the person is responding to treatment. Treating an electrolyte imbalance involves either restoring levels if they are too low or reducing concentrations that are too high. The type of treatment will also depend on the severity of the imbalance. It is sometimes safe for an individual's electrolyte levels to be replenished over time without ongoing monitoring.

Oral Rehydration Therapy

This treatment is used mainly for people experiencing an electrolyte shortage alongside dehydration, normally following severe diarrhoea. The World Health Organization (WHO) has approved a solution to be used in oral rehydration therapy that contains 2.6g of sodium**,** 1.5g of potassium chloride**,** 2.9g of sodium citrate. These are dissolved in one liter of water and given orally.

Electrolyte Replacement Therapy

In more severe cases of electrolyte shortage, the substance can be given to the individual either orally or through an intravenous drip. A shortage of sodium, for example, can be supplemented with an infusion of saltwater solution or compound sodium lactate. An excess can occur if the body loses water without losing electrolytes. In these cases, a solution of water and blood sugar, or glucose, is given.

Prevention

Some causes of electrolyte shortage, such as kidney disease, cannot be prevented. However, a well-managed diet can help reduce the risk of a shortage. Consuming a moderate amount of a sports drink following physical exertion or exercise can help limit the impact of losing electrolytes in the sweat.

Conclusion

The human body is an intricate system with sensitive chemical balances. It's important that delicate electrolyte balance to be maintained. Any disruption in the electrolyte balance can have a cascading effect, with some more severe than others. To prevent any disruption or disturbance, it is vital to maintain a healthy diet. The best way to maintain a healthy body is to have a nutrient-rich, well-balanced diet, while avoiding added sugars, junk foods, fats, and excessive carbohydrates.

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Sustainable Agriculture as an Engine for Sustainable Development

Article ID: 12028

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Summary

Agriculture has been and will always remain the most important sector of a national and global economy. It provides the ultimate in essential food and fiber for the world's population. No industrial substitutes have yet been found to replace food requirement. Thus, the long-term survival of mankind will depend on the sustainability of the agricultural economy.

In light of its importance, the present article provides a brief conceptual summary of the meaning, need and components of sustainable agriculture. It highlights some of the practices and strategies adopted for encouraging sustainable agriculture and hence sustainable development.

Introduction

Agriculture is central to sustainable development. About 70 per cent of the poor in developing countries live in rural areas and depend in one way or another on agriculture for their survival. Progress in agriculture, therefore, provides the best safety net against the poverty and hunger that exist in many countries of the world.

It has the potential to make a unique contribution to a more sustainable society. Not only can it assure the continued development of an environmentally-sound supply of food to meet the needs of the rapidly expanding world population, it can also provide for the conservation of the rural environment with its habitat, genetic biodiversity, landscapes and cultural traditions. Because of its important role in the economy of most developing countries, sustainability of agriculture is identified as an engine for development.

Agricultural Development in India

Agricultural development in independent India can be divided into 3 distinct phases. The Phase I started during 1950, wherein local cultivars, indigenous technology, green manuring being the inputs and the expected output were quite low. Alarming rise in the population rate forced the scientists to think of alternatives to the local cultivars with higher response to fertilizers and jump in yield levels. This marked the beginning of Phase II (1965), wherein high yielding varieties, fertilizers, mechanization and irrigation were used as the inputs and production increase was lucrative. And this phase was popularly called as 'Green Revolution' phase in the History of Indian Agriculture.

But after 20-25 years the impact of high input technology was reflected in the degradation of agro-ecosystem and once again forced the scientists to think of a viable option to keep intact the resource base and to harvest more sustain yield levels to feed the burgeoning population. This being the third phase is popularly called as phase of sustainable agriculture started from 1980's onwards.

Need for Sustainable Agricultural Development

Historically, agriculture played an important role in human development. It faces daunting challenges because of increasing population growth and changing food consumption patterns, natural resource scarcity, environmental degradation, climate change, and global economic restructuring. To feed the world and to feed it well, global food production will need to double by 2050. The problem, however, is that half of the habitable land on Earth is already used for farming. As resources are limited, the challenge is to achieve global food security while having a positive impact on the environment and society. Sustainable agricultural practices provide the solution.

Meaning of Sustainable Agriculture

Sustainable agriculture is both a term and a concept whose definition has varied a great deal. As it pertains to agriculture, sustainable describes farming systems that are "capable of maintaining their productivity and usefulness to society indefinitely. Such systems... must be resource conserving, socially supportive, commercially competitive, and environmentally sound (Ikerd, 1990). Sustainable agriculture can be defined in many ways, but ultimately it seeks to sustain farmers, resources and communities by promoting farming practices and methods that are profitable, environmentally sound and good for communities. Sustainable agriculture fits into and complements modern agriculture. It rewards the true values of producers and their products. It draws and learns from organic farming. It works on farms and ranches large and small, harnessing new technologies and renewing the best practices of the past.

Components of Sustainable Agriculture

Sustainable agriculture has environmental, social and economic dimensions – and all three must be considered together. Focusing on one or two in isolation will not give the desired results.

1. Protecting and improving the natural environment are fundamental, and issues like climate change, energy, water scarcity, and biodiversity and soil degradation need to be addressed.
2. The social dimension covers labor rights and the health of communities, including access to and affordability of food, labor rights and community health. Food quality, safety and animal welfare are also important social aspects.
3. On the economic side, sustainable agriculture is productive, efficient and competitive. The benefits should be seen in farm profitability, in thriving local economies, and throughout the whole value chain.

Sustainable Agricultural Practices for Sustainable Development

In recent years, the agriculture sector has been paralyzed with low productivity, soil erosion, environmental degradation, greenhouse gases, adversities in biodiversity, uneconomic operations, increasing use of unhealthy means in farming, etc. This has ignited a debate on the sustainability of the agricultural sector. With the growing earth imbalances, the concept of sustainable agriculture has received international attention. Sustainable agriculture integrates environmental, economic and socio-cultural considerations in agricultural practices. Initiatives towards sustainable agriculture have provided a wide vision for present and future needs of the society. It has the potential to provide solutions on the emerging issues related to livelihood, social, cultural, economic and environmental problems. Issues like increasing cost of farming, declining fertility of soil, land use patterns, competitive pricing of the agricultural produce, growing imbalances in the natural ecological settings, issues in biodiversity, commercialization of agriculture etc. can well be addressed through sustainable agriculture practices. Sustainable agricultural practices include (United Nations Environment Programme, 2015):

1. Crop rotation that alleviate weed, diseases, and insect problems; increase available soil nitrogen, reduce soil erosion and reduce the need for synthetic inputs.
2. Integrated Pest Management reduces the requisite for pesticides by crop rotations, scouting, and timing of planting, biological pest controls.
3. Management systems to improve plant health and crops abilities to resist pests and diseases.
4. Soil conserving tillage.
5. Water conservation and water harvesting practices.
6. Planting of leguminous crops and use of organic fertilizers for improving soil fertility.

Strategies to Promote Agricultural Sustainability

The major objective of sustainable agriculture is to increase food production in a sustainable way and enhance food security (Bhatnagar and Bhatnagar, 2012; United Nations Environment Programme, 2015).

1. This will involve education initiatives, utilization of economic incentives and the development of appropriate and new technologies, thus ensuring stable supplies of nutritionally adequate food, access to those supplies by vulnerable groups, and production for markets; employment and income generation to alleviate poverty; and natural resource management and environmental protection.

2. The priority must be on maintaining and improving the capacity of the higher potential agricultural lands to support an expanding population. However, conserving and rehabilitating the natural resources

on lower potential lands in order to maintain sustainable man/land ratios is also necessary sustainable agriculture.

3. The main tools are policy and agrarian reform, participation, income diversification, land conservation and improved management of inputs. The success of sustainable agriculture will depend largely on the support and participation of rural people, national Governments, the private sector and international cooperation, including technical and scientific cooperation.

Conclusion

Agriculture has to meet its challenges, mainly by increasing production on land already in use and by avoiding further encroachment on land that is only marginally suitable for cultivation. Fostering rapid, sustainable and broad-based growth in agriculture is therefore, a key priority keeping in mind the overall socio-economic development trajectory of the nation. Major adjustments are needed in agricultural, environmental and macroeconomic policy, at both national and international levels, in developed as well as developing countries, to create the conditions for sustainable agriculture development. Especially in the light of existing vulnerabilities that relate to a shrinking land resource base, additional stresses arising from the non-agricultural sector and issues emerging due to changing climate.

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Healthy Soil Healthy Life

Article ID: 12029

Sharmistha Pal, Pempa Lamu Bhutia, Manoj Kumar

Soil health is closely related to human health. The starting point of food chain is soil and it reaches to human body through plant or animal. Thus, it is said that human health is a virtual reflection of soil health. Due to ever increasing population pressure, there is heavy pressure on soil, and thus, soil health is being deteriorated. Soils act as a reservoir of nutrients, also act as natural filters to remove contaminants. A healthy soil, is full of life. Millions of species and organisms make up a complex and diverse mix of micro and macroscopic life residing in soil. The soil dwelling organisms need food and shelter. Soil organic matter is the major food source for organisms. As a group, soil organisms cycle nutrients and helps to build up soil structure. Those soil organisms, in turn, cycle nutrients back to the plant, allowing it to grow and flourish.

Soils are recognized for significant contributions in supply of nutritious food products, medications, which assists in developing human immune system. Negative human health impacts also occur when foods are grown in nutrient deficient soils or soil containing toxic levels of chemicals or pathogenic organisms. Soil plays a crucial role in mitigating the effects of climate change, increasing farm productivity and ensuring food security. Soil and society are inseparable but due to excessive use of agrochemicals, the soil health is deteriorated and thus, soil is bound to be sick. Another major problem is the mining of soil fertility due to inadequate replenishment of nutrients due to excessive nutrient uptake by high yield varieties and intensive cropping intensity. The soil is where food begins. Soil is the basis of all food production. The qualities of food we consume are reflected in human health. Thus, human health status corresponds to the status of soil quality or fertility.

E-ISSN: 2581 - 8317

Earthworms and Soil Fertility

Article ID: 12030

Sharmistha Pal, Pempa Lamu Bhutia, Manoj Kumar

Earthworms play a pivotal role in improving soil fertility in a number of ways. Earthworms mix up the soil layers, incorporate organic matter into the soil and improve soil structure and fertility. The earthworms consume surface organic matters, promotes decomposition and recycle the nutrients locked up in soil organic matter. Earthworms through excretion process, release these materials in the form of cast. The earthworm cast is rich in nutrients and also more available to plants. The abundance and distribution of earthworms in soil depend on the quantity and quality of crop residues in different agro-ecosystems. Organic matter is the major source of food for earthworms Crop residues with low C:N ratio is palatable and is preferred by most earthworm species than residues having higher C:N ratio. Earthworms enhances mineralization of soil organic matter and thus add to the nitrogen in soil due to enhanced nitrification in earthworm casts. A number of factors affect activity, population density, abundance and distribution in soil. These are soil organic matter content, soil type, soil moisture, soil temperature, soil pH are most critical factors that govern the earthworm population. Earthworms require adequate moisture for growth and development. Earthworm's activities are higher in moist soil than in dry soil. Temperature affects the growth, metabolism, activity and reproduction of earthworms. Higher temperatures above the critical limit for survival can kill earthworms. Temperature tolerances and preferences of earthworms vary from species to species. But, the earthworm population in soil is threatened by a number of agricultural practices such as intensive tillage operation, excess application of chemical fertilizers *etc.* Cultivation decreases the number of earthworms progressively with time. Pesticides, heavy metals and agricultural chemicals affect earthworm abundance and distribution directly by interfering with earthworm activity, decreasing their count and finally causing earthworm mortality.

AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Drumstick: The Miracle Tree

Article ID: 12031

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Introduction

Drumstick (*Moringa oleifera* Lam.) is one of the important perennial vegetables grown in India, belongs to family Moringaceae. In India it is grown all over the subcontinent for its tender pods and also for its leaves and flowers. Although Saijan originated in India, but due to its use as a medicine, it has reached other countries as well. Every part of the plant is valued for food. It is highly nutritious with high levels of minerals and vitamins. Drumstick leaves, which are the most nutritious part of the tree, are rich in vitamins, while the roots are rich in minerals. The stem is rich in vitamin C and the flowers and seeds are rich in potassium. The pod and flower also have enzymes that help bring down cholesterol level. Moringine compound discovered from the plant, is anti-diabetic in nature and thus initiate insulin secretion. Drumstick leaves have 30 and 100 times more iron and calcium, respectively than spinach. Moringa has been used for centuries due to its medicinal properties and health benefits. It also has antifungal, antiviral, antidepressant, and anti-inflammatory properties. It is also known as drumstick tree, miracle tree, ben oil tree or horse radish tree. Moringa has been used for centuries due to its medicinal properties and health benefits. It also has antifungal, antiviral, antidepressant, and anti-inflammatory properties.

Moringa Parts and their Uses

S.N.	Part	Uses
1.	Stem	Animal feed
2.	Twig	Animal feed
3.	Leaves	Animal feed, growth hormones, human consumption, and medicinal uses
4.	Bark	Dyes, tannins, and medicinal uses
5.	Roots	Medicinal uses, and human consumption
6.	Pods	Medicinal uses, and human consumption
7.	Seeds	Seed shells are used for fuel whereas kernels oil is used for cooking, cosmetics, medicinal and industrial uses, meal obtained after oil removal is extracted meal used as animal feed and meal coagulants are used in water purification.

Climate and Soil

Drumstick is a brash natured plant growing in different ecological conditions. It can survive in drought conditions. This plant grows even in low quality soil. Warm and humid climate for its growth and dry weather for flowering are perfect. Generally, at an average temperature of 25-30°C, the drumstick plant has a green and widely spread development, also favorable for flowers to bloom. It also tolerates frost. But frost damages the plant. At the time of flowering, the flower starts falling at a temperature above 40°C. More or less rainfall does not harm the plant. Drumstick plant grows well in dry loamy or loamy soil (which has acidic pH ranging from 6.2 to 7.0 neutral). This plant also tolerates seaside soil and poor-quality soil.

Varieties

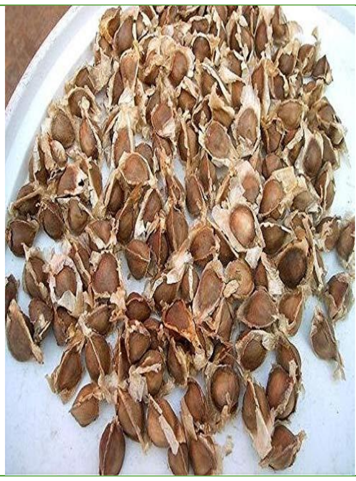
Generally, moringa provides flowers once in a year, but a variety called Najee gives flowers throughout the year.

PKM 1: Yield starts after 8 to 9 months. It is harvested twice a year. About 200 to 350 pods are produced from its plant, which gives yield for 4 to 5 years continuously. Each pod is longer in length and is more in demand especially in the big cities as compared to the local market.

PKM 2: The raw pods of this variety are green in color with better taste. The length of each pod is 45 to 75 cm. Each plant produces about 300 to 400 pods. This variety produces good quality crop but it requires more water.

Coimbatore 2: The length of its pod is 25 to 35 cm. The color of the pods is dark green. Each of its pod is heavy and fleshy. Each plant produces about 250 to 375 pods. Each plant gives yield for 3 to 4 years. Delay in harvest will reduce the market value.

Rohit 1: It starts production after 4 to 6 months of plantation and continue for 10 years (Two crops in a year).

		
Drumstick Plant with pods	**Drumstick Seeds**	**Leaves and flowers**

Land Preparation

Drumstick seedlings are planted in pit (45 x 45 x 45 cm) at a distance of 2.5 x 2.5 meters. The field should be kept free of weeds. 10 kg of rotten cow dung mixed with the top soil of the pit and fill the pit. This makes the field ready for planting the seedlings.

Propagation

In drumstick, both seed and hardwood cutting are used for propagation. May - June is best time for seed sowing and 15 cm x 7 cm polythene bag can be used. Generally, two seeds are sown in each packet and kept under the shade and watered regularly. After 8-10 days germination takes place. It is good to propagate from seed for more yield and twice crop within a year. For one hectare, 500-gram seed is sufficient. Seeds can be sown directly in prepared pits or seedlings are planted in pits after preparation in polythene bags. The seedlings are ready to plant within a month.

Crop Management

One month old seedlings are planted in already prepared pits in the month of July-September. When the seedlings are about 75 cm then cut the upper part of the plant to produce a greater number of side branches. After three months of planting, apply 100 g urea, 100 g super phosphate, 50 g potash are added per pit and after three months re-treat 100 g urea per pit. From the research done on drumstick, it was found that only 15 kg of dung manure per pit and Azospirillum and PSB (5 kg/ha) can be used for organic drumstick cultivation without any loss in yield.

Irrigation

Irrigation is beneficial for good production. If the seed is propagated in the pit, it is necessary to maintain moisture till the seed germinates and is well established. If the field is too dry or too wet at the time of flowering, there is a problem of flower drop in both the stages. Irrigation during dry season helps for better growth of plants.

Plant Protection

In water logged conditions diplodia root rot can occur. To drain off excess water seedlings are planted on mound. Caterpillar, hairy caterpillar, etc. are common insects of drumstick cause defoliation. Conveniently it controlled by soap solution applications at early stage (larvae) and by application of Dichlorovas 0.5 ml at mature stage (adult). Dissolving in one liter of water and spraying on plants gives immediate benefits.

Harvesting

Varieties, which bear pods twice a year, is generally harvested in February-March and September-October. About 200-400 pods (40-50 kg) obtained from each plant in a year. The harvesting of drumstick lasts for 1-2 months depending on the market and quantity. Harvesting the pods before fiber development, maintains the demand in the market and also gives more profit.

Drumstick Pods After Harvesting

Drumstick gives produce without any special care and at zero cost. People can plant drumstick plants on the unusable land around their homes, where they will be able to get vegetables for own consumption, while selling it they can also achieve economic prosperity.

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WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Microgreens: Tiny Plants with Noval Characters

Article ID: 12032

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Introduction

Diet-related diseases such as cardiovascular disease, diabetes, obesity, hypertension, stroke, cancer occurrence is more due to imbalanced food consumption patterns and non-availability of fresh and pesticide residue free vegetables for consumption, changing lifestyle in developing and developed countries. Microgreens are emerging as good option to prevent this because rich in minerals, vitamins and antioxidants, it can easily be grown in urban or peri urban areas, it has short growth cycle and can be grown with or without soil. Microgreens are vegetable greens (not sprouts or shoots) harvested just after the cotyledon leaves have developed (and mostly, with one set of true leaves). Microgreens (seedlings of edible vegetables, herbs and other plants) are smaller than “baby greens” because they are consumed very soon after sprouting, rather than after the plant matured to produce multiple leaves. Although small in size (8-10 cm in height, 7-21 days old), microgreens can provide crisp textures, vivid colours, and intense flavors and can be served as an edible garnish or a new salad ingredient. Microgreens gain immense potential for improving the nutritional value of the human diet, considering their high content of healthy compounds. They gain more interest not only for their nutritional value but also for their interesting flavours and commercial potential. People also call microgreens a **superfood**.

The wide number of species and cultivars can be grown as microgreens. Microgreens can be grown in a very simple way, even in very small spaces, suitable for urban agriculture, as well as a component of space life support systems. It can be grown without soil and without external inputs like pesticides and fertilizers, inside or around residential areas.

Microgreens Production

Rich Source of Nutrients

There is no concern about loss or degradation of micronutrients through food processing because microgreens are usually consumed right after they are harvested.

The nutritional value of microgreens varies according to their type and growth stages of the plant. However, there are many studies that show seedling (microgreens) may contain a higher concentration of many nutrients, than their mature or fully developed stage.

With their high nutritional value (upto 40 times more than their mature counterparts), microgreens are also considered as functional foods (great content of phenolics, antioxidants, minerals, and vitamins) with particular health-promoting or disease-preventing properties.

Example:
1. Lettuce microgreens (7 days after germination) have the highest total phenolic concentration and antioxidant capacity in comparison to the mature plants.
2. Spinach microgreens generally have higher levels of phytonutrients and the carotenoids than mature leaves.

Health Benefits

Heart Disease: Risk of heart disease can be reduced by microgreens consumption because these are rich in antioxidant e.g., polyphenols. Different animal studies show that microgreens may reduce the level of triglyceride and "bad" LDL cholesterol.

Diabetes: Microgreens have great content of antioxidants which can lower down the risk type-2 diabetes. As per different laboratory experiments it is clear that microgreens may increase cellular sugar uptake by 25–44%.

Certain type of cancers: Antioxidant-rich foods, including polyphenols, may reduce risk of different kinds of cancer.

Alzheimer's disease: Presence of antioxidants (including polyphenols) can reduce probability of memory related disease such as Alzheimer.

Microgreens reduce risk of eye diseases, constipation. It protects the body from harmful effects of free radicals, also helpful to maintain strong and healthy bones and cure anaemia.

Microgreens Production

Microgreens are produced in different environments (protected environment, open air, indoor) and growing systems (soilless, soil), depending on the scale of production. Mainly postharvest quality and safety of microgreens have more importance but some preharvest practices also affect the shelf life, food safety, and postharvest nutrition profile of microgreens.

Microgreen Selection

Microgreens can be grown from different types of seeds. Plant families most commonly known for microgreens:

S. N.	Family	Crops
1.	Amaranthaceae	Amaranths, spinach
2.	Amaryllidaceae	Garlic, leek, and Onion
3.	Apiaceae	Carrot, celery, coriander and fennel
4.	Asteraceae	Lettuce
5.	Brassicaceae	Arugula, Broccoli, cabbage, cauliflower, kale, mustard and radish
6.	Cucurbitaceae	cucumber, melon, and squash
7.	Fabaceae	Sweet pea, alfalfa, fenugreek
8.	Lamiaceae	Mint, basil

Soil

Microgreens grown in soil, works the best. The soil should be free from any chemical or pesticide quantities, to obtain organic and healthy produce.

Pot/ Tray

A container required to grow microgreens. A seed tray from any hardware store or a nursery, a regular planting pot or a baking dish with 4-5 inches depth will also solve the purpose.

Light Source

At least 3-4 hours a day essential amount of sunlight natural light required for microgreens. Greenhouse growers often supplement the natural light with "grow lights".

Water

Most important element is water for microgreens. The soil which used should be moist at all times. Hand sprinkler works best for plant, due to its micro-outlets that do not let open a huge downpour of water. Use of fresh tap water instead of any chemically treated water is best for Microgreens.

Harvesting

Most species are harvested at the appearance of the first true leaves, with fully expanded cotyledons, still turgid, retaining their typical colour, and seedlings having a height of 5-10 cm. Seedlings should be cut down manually or mechanically few millimeters above the growing media surface. Focus should be placed to exclude growing media particles and seed integuments which in some species retain with the cotyledons. Some types will re-grow and can be cut several times.


Microgreens After Harvesting

Post-Harvest Management

Microgreens have a short shelf life. Hence, require better methods of storing and transporting. Commercial microgreens are most often stored in plastic clamshell containers and refrigeration @2.5-3.5 °C up to 7 days. Biodegradable Clamshell containers also used.

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WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Fly Pest Infestation in Mushroom and its Management

Article ID: 12033

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Introduction

Edible mushrooms are found in backwoods, decrepit terrains, and developed territories. Wild species for the most part devoured locally by tribal people who don't embrace any control measures against pests and diseases. Mushroom production speaks to probably the best model in farming where pests can be controlled without the utilization of synthetic pesticides. The fundamental principles necessary to manage fly pests is the recognition of the problem through its damage symptoms and understanding its life cycle and identification. In cultivated mushrooms, chemicals are extensively applied to maintain room disinfection and reduce damage caused by insects and diseases. Synthetic insecticides and insect growth regulators are routinely applied after spawning and during casing, a week later, and between flushes up to 2 days before harvesting (Anonymous, 2010). For commercial production, mushrooms are cultivated under controlled conditions indoors or outside, direct control over its pests is quite achievable.

Dark Winged Fungus Gnat

Sciarids are commonly known as the dark-winged fungus gnats, sciarid, big flies or mushroom flies. The predominate fly species are *Lycoriella ingenua* (syn. *L. mali, L. solani*), *L.castanescens* (*L. auripila*). The gnat severely attacks *Agaricus bisporus* but it can also breed on Oyster and Shiitake mushrooms.

Activity: Incidence of pest is more due to over wet condition of beds, increased temperature and poor culture. The peak activity of pest was noticed during mid-January to mid-March. During warmer months, they will move from building to building, and to farms several kilometers distant. In temperate climates in the winter with outside temperatures below 7°C, sciarid populations are lowest since migration and outside reproduction is limited due to temperature

Damage: Adult female lays eggs within the growing substrate. Larvae on hatching prefer to feed on the mycelial growth and pin head mushrooms. It enters the mushroom by tunneling the stipes and on reaching pileus feeds vigorously. As a result of feeding the mushroom will appear glossy and light brown, the small carpophores may be completely perforated and crumbles easily when picked. Some larvae do not tunnel into stipe but consume the mycelia at the base of stipe causing abnormal development of mushrooms. It is a vector of Dry bubble disease (*Lecanicillium fungicola* (Preuss*)* Zare) and green mold disease (*Trichoderma aggressivum* Samuel).

Cecid Fly

Small and rarely seen flies. Species like *Mycophila speyeri* Barnes, *Heteropeza pygmaea* Winnertz, and *Mycophila barnesi* Edwards (Chung and Snetsinger, 1965) are associated with commercial mushroom production.

Activity: Incidence starts from second week of spawn run period and with increased air temperature during spawn run period increases the attack by the fly. They show rapid and jerky movement in presence of light. Flight of fly is limited by temperature (below 12˚C).

Damage: Young larvae feed on growing mycelium and tear the bundle of hyphae. It may be found in stalk and cap of mushroom in severe infestation causes spoilage of mushroom.

Phorid Fly

Commonly known as humpbacked flies or scuttle flies. Six species have been reported from commercial mushroom facilities in the US (Robinson, 1977) but the predominant species is *Megaselia halterata* (Wood). DAMAGE: *Megaselia halterata* larvae feed at the growing hyphal tips of the mushroom mycelium. Yield loss is related to the number of larvae grazing on the mushroom mycelium.

Management:

a. Physical methods:

i. Polythene sheets coated with sticky material and connected to a fluorescent strip light in every cropping are facilitate in controlling adult flies. Insects get attracted to white light above 15^0 C and to yellow light at lower temperature.

ii. Poison baiting with Baygon diluted with water (1:10) with addition of very little sugar is an efficient technique of fly control in cropping rooms.

b. Cultural control:

i. Heat treatment of recent compost at 60-65° C for 8-12 hours so as to kill all stages of flies. It conjointly helps in killing most disease inflicting fungi and bacteria.

ii. Screening of rooms with nylon net of 35-40 mesh size.

iii. Sealing of cracks in walls, and around air conditioners, pipes and doors, that are the standard routes of initial fly invasion.

iv. Spent compost and mushroom stumpage ought to be far from the premises because it is breeding material for flies.

v. Drying of mushroom growing house i.e., gap between two growing seasons.

c. Biological/Biorational control:

i. *Bacillus thuringiensis* var. *israelensis* and diflubenzuron tend to be more effective against younger larvae, whereas entomopathogenic nematodes, particularly *Steinernema feltiae*, and methoprene are more effective against the older larvae.

ii. The biological control agent *Steinernema feltiae* are applied immediately following casing for Sciarid fly. It's obtainable in pack sizes of 150 and 300 million nematodes and therefore the rate of application is 3 million nematodes/m^2. The nematodes are developed in an exceedingly fine-grained inert vermiculate carrier and must be refrigerated (5-10°C) throughout storage.

iii. Various predatory mites, *Stratiolaelaps (Hypoaspis) miles* (Berlese), *Geolaelaps (Hypoaspis) aculeifer* (Canestrini), and *Stratiolaelaps scimitus* (Womersley), have incontestable success against various sciarid species (Castilho et al., 2009).

d. Chemical control:

i. At the time of the attack of the mushroom flies a spray should be done in inside of the wall and floor of the mushroom house with Dichlorovas 76 EC 0.5ml or Malathion 50 EC @ 1 ml should be added in one liter of water at the interval of 3-4 days. It is advisable not to spray on the mushroom beds and buttons.

ii. Spray 30 ml Nuvan 76 EC at 22.5 g a.i./100 m^3 by ULV when mushroom flies are noticed in cropping rooms. After spraying close the doors and ventilators for 2 hours. Avoid direct spray on mushroom beds. There should be an interval of 48 hours between spraying and picking of mushroom.

iii. Application of Permethrin dust (10g a.i/kg) also helps in fly's management, without any residue problem.

iv. Pyrethrum at 1 cc/cm applied as smoke or aerosol provides effective management of larvae and adults.

v. To check the adult fly spray application of Fenvalerate and Cypermethrin (0.05%) on walls, floors and galleries. 1.2 to 1.0 g Diaflubenzoran 25WC or Nimbicidin (0.03%) 100 ml/ lit. to be added in 13-14 liter of water to combine in 100 kg compost which must be added in the last turning of the compost. Out of this, anyone insecticide should be taken and used at the time of casing.

vi. Adulticides within the kind of aerosols or dusts should be applied once the action threshold is reached and may be used meagerly and alternately with different products of various mode of action to increase the effectiveness of the product.

Conclusion

No doubt insect pest management in Mushroom cultivation may be a terribly tedious job. However, if we tend to aware of the seasonal incidence of fly pest together with their biological and behavioral habit it will be quite simple to tackle the pest management. It's documented that Integrated Pest Management may be a cardinal principle for pest management now days. And it is indispensable to follow some prophylactic measures before opting to chemical method or if it is then solely in an integrated approach. So, the behavioral activity provides us the essential plan for once and the way fly pest to be controlled and which method to be enforced.

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Spiders

Article ID: 12034

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Introduction

Spiders are air breathing Arthropods with four pair of legs and chelicerae with fangs by which they inject venom. Among 15 orders of Arachnids, order Araneae is the largest and ranks seventh in species diversity of all known orders of organism.

Spiders are found worldwide in every continent except in Antarctica because of extreme cool climate and higher altitude, established nearly in all habitat except air and sea colonization. It accounts for destruction of 400 to 800 million tonnes of prey every year on the Earth. Nearly 48,200 species have been recorded under 120 families till July 2019.There are 1800 species in India accounting 4 % of Arachnids in the world.

Life Cycle

Commonly life span of spider ranges from nine months to 20 years. Most species live 2 to 3 years. The life span depends on climatic condition where life span is longer in colder areas and shorter in warmer conditions.

Spider lays eggs inside egg sac covered by woven silk inside the web or in some species like wolf spiders the egg sac will be attached to the spinneret. Each female can lay about 10 to 12 egg sacs in her life span each accounting 150-200 eggs per each sac. Spiderlings hatch after 2-3 weeks from egg sac after laying. First moult usually occurs inside the egg sac. Generally, 5-9 moults are encountered which varies with species and sexes.

How Spider Differ from Arthropods?

1. Antennae: Spiders lack antennae which is present in almost all Arthropoda's.

2. Extensor muscles: Spiders don't have extensor muscles in limbs but extend the limbs by hydraulic pressure, where it has capacity to generate pressure up to eight times of their body weight.

3. Respiration: Spiders respire through book lungs where other Arthropods respire through trachea.

How Spider Differ from Other Order Members?

1. Narrow Waist: Spiders possess petiole like structure between cephalothorax and abdomen which was not found among other members of the order Araneae.

2. Spinnerets: Spiders have silk spinning organ usually three pairs found at the end of abdomen which are short movable organ used to spun the silk with 6 types of silk glands to which spigots are connected.

3. Ballooning: Spiderling's hatching will climb as high as it can, stands on raised legs with its abdomen pointed upwards and starts producing silk which automatically form a triangular shaped parachute which will blow away with mild wind. This is the by which spiders move from one place to other.

Facts About Spider?

1. Goliath bird eating spider (*Theraphosa blondi*): It is the largest and heaviest known spider species in the world with 28 cm (11 inches by its leg span) and weighs about 175 g respectively.

2. Herbivore feeding spider (*Bagheera kiplingi*): All spiders are known to feed on insects but this species was known to feed on flowering plant *Vachellia* spp found in Central American reported in 2008.

3. Smallest spider (*Patu digua*): Commonly called dwarf orb weavers, where males are about 0.37mm in size roughly around one fifth size of head of pin.

4. Trapdoor spider: This is the long-lived spider up to 43 years in Australia which was killed by wasp bit.

5. Darwin bark spider (*Caerostris darwini*): It belongs to orb-weaver spider produces web ranging from 900-28,000 sq.cm. This is the largest web building spider.

6. Fishing spider: Bolas spider are unusual orb-weaver spider that do not spin webs. Instead, they hunt by using a sticky capture blob of silk on the end of line known as bolas. It is referred as fishing spider because of its prey capture nature which is similar to fishermen snagging a fish on a hook.

Web Types

1. Trapdoor web: Constructs burrows with a cork like trapdoor made of soil, vegetation and silk. Spider detects prey by vibration.

2. Diving bell web: Female water spider builds underwater diving bell webs which are filled by air.

3. Orb webs: Spiral shaped webs, these webs built by Araneidae.

4. Cob web/ tangle: Tangle shaped usually associated with Theridiidae.

5. Funnel web: Funnel shaped webs, associated with Agelenidae.

6. Sheet web: Constructs in the form of sheet on vegetation by small spiders belongs to Linyphiidae.

Why Spiders are Good Predators?

1. Polyphagous nature: It preys on diverse range of insect species of variable size and all stage of insect.

2. Predatory nature: Adults and Spiderlings feed on insect species.

3. Withstand extreme climatic conditions: It can survive even in varied and extreme climatic conditions by varying its metabolic rate.

4. High resistance to starvation: Reproduction rate of spider is not affected even with the low prey availability.

5. Availability: spiders are available throughout the year because of its generalist feeding behavior where decline in any specific insect species will not affect its availability.

6. Distribution by wind: Ballooning in spiders.

How Best Spiders can be Used in Insect Pest Management?

1. Conservation:

- **a. Selection of insecticides:** Use of emulsifiable concentrates insecticide formulation.
- **b. Time of spray:** spraying insecticides in inactive hours of spiders.
- **c. Planting and harvesting procedures:** Use of methods which creates less disturbances.
- **d. Ecological engineers or hedge planting:** Growing of beneficial flowering plants in the boarders will attract the insects for pollen and nectar collection which acts as alternate food for spiders in off seasons and even it provides shelter during non-crop season.

  Example: In Japan for conservation of spiders, they will release the mass reared Drosophila species into the fields so that the spiders can consume and survive during off season.

2. Augmentation: Release of spiders from spider rich area to needed area. In China, where straw bundles are placed in spider rich areas, a week later these straw bundles with spiders are placed in the fields where the control as to be brought by spiders.

Predation of Spiders on Termites

Harvester termites *Hodotermes mossambicus* which are termite's species known to damage grasslands especially during long period of drought, where these termites are controlled by one specific spider species called *Ammoxenus* spp.

Which is free living soil dwellers known as sand divers. They detect insect by the vibration of sand and chemical clues. Spider kills termites by paralyzing by the venom and stored in the dwell consumed at needful times. Identification of specific insect feeding spiders helps to exploit spiders in insect pest management in various agriculture and horticulture ecosystem.

Conclusion

Spiders are efficient predators against insects in various ecosystem, but its use is restricted in agroecosystem as it is generalist feeder, cannibalistic nature and difficult in mass multiplication. There is wide scope for exploration of spiders in managing insect pest which will fit into IPM program in future by their polyphagous nature, withstand extreme climatic condition, high degree of resistance to starvation.

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Hearing in Insects

Article ID: 12035

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Introduction

1. Hearing plays a crucial role in insects, to detect and avoid predators, to locate and select mates and for communication with nest mates in social insects and other useful functions, both within and between species.

2. Insects have single hairs to complex tympanal ears for hearing. Cicadas and Katydids have good hearing because of their conspicuously loud calls but coleoptera, hymenoptera and diptera reports conspicuous sound emissions are rare.

3. An acoustic signal is generated by the vibrations of a sound-producing structure and its reception requires the detection of those vibrations by appropriate mechanoreceptive organs.

4. Insect produces sound; part of the vibration energy may be propagated through the substrate upon which the sender is standing and part through the air.

6. However, substrate signals can be considered part of a general class of signals that include acoustic (airborne) signals, and when considering the structure, function, and evolution of the organs for signal production. Those insects that produce substrate signals and are sensitive to them, we are no longer talking about an apparent small minority of insects.

Sound-Producing Mechanisms in Insects

1. Vibration: Sound emission which results from vibration occurs from oscillations of the abdomen, either dorsoventrally or laterally, and/or by the wings. Neuropteran, plecoptera, trichoptera, diptera, hemiptera, heteroptera.

2. Percussion: Stricking of one body part against another or substrate with the tip of the abdomen. Lepidoptera, orthoptera, coleoptera, hymenoptera, isoptera, blattodea.

3. Sridulation: Sounds produced by frictional mechanism, through the movements of two specialized insect body parts against each other in a regular patterned manner. Orthoptera, plecoptera, blattodea, hemiptera, heteroptera.

4. Click mechanism: Sounds rely on the deformation of a modified area of cuticle generally by contraction and relaxation of special musculature within insect body. Hemiptera, heteroptera.

5. Air expulsion: Unusual exhalatory sounds, often expelled via the tracheal spiracles, blattodea, lepidoptera.

Evolutionary Emergence of Insect Hearing

The first insects that took to land some 400 million years ago were presumably deaf. From the initial perception of substrate vibrations, hearing evolved during the subsequent diversification of insects, which led to 30 orders and more than 900,000 species.

During this diversification, the ability to hear airborne sounds evolved independently multiple times within at least nine insect orders: Orthoptera, Mantodea, Blattodea, Hemiptera, Hymenoptera, Coleoptera, Neuroptera, Lepidoptera, and Diptera.

Major Driving Factors Promoted the Evolution of Hearing in Insects

1. Acoustic communication, which can operate over large distances in cluttered environments.
2. Acoustic detection of predators, most prominently echolocating bats (Gopfert and Henning., 2016).

Making of Insect Ears

Hearing relies on auditory sensory organs that convert sound-induced mechanical vibrations into electrical signals. With the exception of sound-sensitive filiform hairs, all the known insect auditory organs are derived from Chordotonal organs-internal stretch receptors that are serially arranged along the insect body. Chordotonal or scolopophorous organs are subcuticular receptors that act most commonly as joint proprioceptors or as hearing organs (Fig 1).

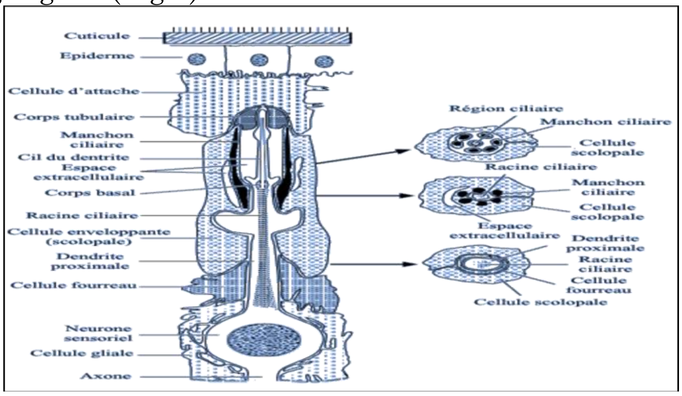

Fig. 1 Structure of the Chordotonal organ

Functioning of Chordotonal Organ

Chordotonal organs are structurally complex Type-I mechanoreceptors that are distributed through the insect body and function to detect a wide range of mechanical stimuli, from gross motor movements to air-born sounds.

Auditory Organs in Insects

1. Johnston's organ: Located at the base of the antennae. Respond to partical-velocity component of sound. Ex: Honey Bee, Flies, Mosquito *etc.*

a. Near field sound detector

b. Honey bee's worker responds to the sound produced by incoming dancing workers (Versteven *et al.,* 2016).

c. Mosquito-perception of female courtship song.

2. Janet's organ: Antennae of Hymenoptera. Detects flexion of the antennal joints.

3. Subgenual organ: Proximal part of tibia. Contains 10-40 scolopedia, 400 in parasitoid wasp. **Function:**

a. *Chrysoperla* (Neuroptera) and Auchenorrhyncha (Hemiptera) -intraspecific signals.

b. Parasitoid wasp detect the wood boring prey.

4:

a. Tympanal ears: Called eardrum. Respond to pressure component of sound. Present in 7 orders of insect and found in various locations on the body. Ex: Cricket, Katydid, Moth, Mantids *etc.*

b. Atympanal ears: Some species of Sphingid moths.

Significance of Hearing in Insect

1. Signals having interspecific significance:

a. Syrphid flies look like bees and wasp mimic their sounds in order to avoid food competition.

b. Australian predatory tettigonid mimic the sounds of cicadas and prey the attracted cicadas.

2. Reproductive isolation.

3. Attraction from a distance.

4. Courtship: Ex. Male cicada produces loudest sound- up to 1 Km. Bladder grasshopper- recognize its mate calling song up to 450m.

a. *Gryllotalpa* - 100 m

b. Territorial aggressive stridulation is seen in territorial cricket species such as *Grillus campastris* and *G. bimaculatus.*

5. Territorial behavior and competition

6. Communication in social insects:

a. Ex. Dancing bees – worker bees produce sound by thoracic and side to side movement of gastor in order to communicate with nest mates' regarding to convey the message about nature, direction and distance.

b. Honey bee queen produces Piping and Quaking sound by flight muscles, just prior to the emergence of new queen to convey the message about smarming flight muscles.

c. Ants produces audible acoustic sounds and pass the information about food sites and recruitment of defend against intruder and reinforcement of social status.

d. Upon disturbance *Zootermopsis* species termites produces drumming sounds by their heads rubbed against the substratum and give the information for retract to remoter parts of the nest.

Conclusion

Many insects have ears for the sole function of detecting predators. Nocturnally active insects tuned to the ultrasonic vocalizations of insectivorous animals and also designed for conspecific communication between insects. The study of insect hearing has inspired the scientist to discover new theories with medical implications. Hearing regulates aggression behavior in Drosophila with an important role in obtaining food, mates, territory and social status. Insect hearing research can be medically relevant in that can help define causes of human ciliopathies and hearing disorders and in that it might offer strategies to control insects that transmit human diseases. Above all, insect auditory systems remain fascinating; they still hold many secrets, and deciphering their function, development, and evolution remains a scientific challenge.

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Health Benefits of Blackgram

Article ID: 12036

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Introduction

Blackgram/urd/mash (*Vigna mungo*) is a native annual pulse crop cultivated in Indian subcontinent is treasure box having not only nutritional value but also several medicinal benefits. Black gram consumption has been dated since the advent of human civilization in various forms. From the fermented *idli dosa* for breakfast to hot poultice of black gram in inflammation of joints and muscle pain, it has served various purpose to mankind. This article gives an overview of health benefit of blackgram.

Nutritional Value

Black gram is a rich source of digestible protein (equivalent to meat protein), fair amount of dietary fiber, potassium, phosphorus, iron, copper, calcium, magnesium, folate, zinc, thiamin, vitamin A, niacin, riboflavin, pantothenic acid, and ascorbic acid. Black gram is one of the best sources of protein especially for people following vegan diet and it is the great alternative to combat protein – energy malnutrition (PEM).

Therapeutic Value

Black grams have anti-inflammatory (reduces inflammation), analgesic (reduces temperature), antiatherogenic (reduces fat deposit in arteries), hepatoprotective (prevent damage to liver), immunostimulatory (stimulate immune system), anticonvulsant (in treating epilepsy, neuropathic pain, mood stabilizer), and antioxidant activity (prevent oxidation).

It is being used in tonic, emollient, as appetizer, astringent, diuretic, and useful in styptic; piles, asthma, scabies, leucoderma, gonorrhea, pains, epistaxis, paralysis, rheumatism, demulcent, in neural disorder, constipation, irregular menstrual cycle.

Black gram is thermogenic in nature thereby affecting metabolic activity. It is also acts as diuretics, helps in excretion of toxic, excess calcium, fatty substances through urine. The amylase inhibitor in black gram reduces absorption of carbohydrate thereby preventing obesity.

Antidiabetic

Hypoglycemic property in black gram is attributed to folate, 10% more amylase compare to other pulses, dietary fibers and α-glucosidase inhibitors. These compounds prevent blood sugars from rising quickly after meal. Dietary fiber present in black gram contributes in slow digestion of carbohydrate either by increasing the viscosity of intestinal contents or by insulating carbohydrate from digestive enzymes.

Good for Heart

Black gram seed have fair amount of α-linolenic acid and oleic acid, these unsaturated fatty acids reduce risk of cardiovascular disease by lowering bad low density lipoprotein cholesterol (LDL) and increasing good high density lipoprotein cholesterol (HDL). Vitamin E. Soyasaponin-I present in black gram can effectively be used alleviate hypercholesterolemia.

Anti-Inflammatory (Pain Reliever)

Black grams have anti-inflammatory properties. Massaging with herbal oil extracted from black gram or using poultice of black gram to reduce pain and inflammation of joints are age old practices. Poly-phenolic and flavonoids present in black gram inhibit cyclooxygenase pathway thus alleviating inflammation and pain. Black gram is one of vital ingredient in popular ayurvedic oil (*Mahamash taila*) to alleviate arthritis pain.

Fertility Booster

Black gram is the best herb for men wellness and remedy for erectile dysfunction. Due to high potassium content, black gram acts as aphrodisiac and prevents infertility. "*Mashaashwagandhadi Churana*" is well known traditional medicine for treating oligospermia. In women too, black gram helps to maintain healthy reproductive system. It is useful in dysmenorrhoea and primary amenorrhea. In urinary tract infection it reduces burning sensation and also very effective in polycystic ovary syndrome (PCOS). Black gram has been reported to help in weight loss in PCOS patients.

Good for Pregnant Women and Babies

Women in pregnancy are often advised to have blackgram in their diet as it is rich in folate. *Ullundu kali* (Black gram porridge) native Tamil nadu dish is a mandatory dish given to pregnant women as this sweet thick halwa harness all the goodness present in black gram. Black gram is galactagogue, increases milk in lactating mother. Nutritional Black gram khichdi is best diet for toddlers.

Aid in Digestion

Black gram consumption increases bulk and moistness of stool therefore results in easy bowel movement. Black gram has substantial amount of soluble mucilaginous polysaccharides. Dietary fiber is bulk laxative and protects the colon mucosa by decreasing its exposure time to toxic substances as well as by binding to cancer-causing chemicals in the colon.

Antioxidant

The seed coat of black gram possesses benevolent quantity of polyphenols such as flavanol glycosides, gallic acid, protocatechuic acid, gentisic acid, vanillic acid, syringic acid, caffeic acid, and ferulic acid which have antioxidant and free radical scavenging properties.

Conclusion

Blackgram offers myriads of health benefits to humankind and these benefits should be popularized so as to keep food basket diverse and healthy.

Blackgram: the handful of health

AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Food Safety Challenges of Street Food and Consumers Safety

Article ID: 12037

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Introduction

Foods and beverages are prepared and sold by sellers on places like streets, schools, train stations, bus terminals, entertainment areas, motor parks, major markets, construction sites, shopping complexes, work places, factories, hospitals and festival areas where people are crowded. Street food popularly known as ready to eat food is present everywhere now a days. Food and Agricultural Organization defined 'street-food' as a wide range of ready-to eat foods and beverages that are prepared and sold by mobile or stationary vendors and hawkers especially on streets and around public places for immediate consumption or consumption at a later time without further processing or preparation (FAO, 2009). Street-foods are an extremely different food category, ready to eat meals, drinks and snacks which are sold on street either on push carts or baskets or from a temporary stall. Street foods are substitute to homemade food and are more affordable as compared with the food supplied at the restaurants. Street foods have become popular in all the countries. These street vended foods provide a source of inexpensive, convenient and often nutritious food for urban and rural poor, a source of attractive and varied food for tourists which also provide a major source of income for a greater number of persons for self-employment with less money investment. Therefore, street foods are well appreciated by consumers because of their taste, reasonable price and easy availability. It is estimated that around 2.5 billion people all over the world eat street foods every day and consumption of street food will continue to grow (FAO, 2009). The street food industry has a crucial role in the metropolitan cities and towns of many developing countries in meeting the food demands of the urban dwellers. It provides meal to millions of people daily with a wide variety of foods that are relatively cheap and easily accessible. In contrast to potential benefits, it is also recognized that street foods are perceived to be major public health risk due to lack of basic infrastructure such as potable water, cooling systems, waste disposal facilities, toilets, hygienic conditions and services and also due to difficulty in controlling large numbers of street food vending operations. Various risk factors related with street foods cut across all stages, including procurement and selection of raw materials, transportation, preparation, cooking, storing and serving of food. Mostly it is seen that most street food vendors are often unlicensed, poorly educated, untrained in food hygiene. Further, many street food vendors work under unsanitary conditions with little or no knowledge about the causes of food borne diseases. People who often consume street food have been reported to suffer from food borne illness such as dysentery, diarrhoea, cholera, typhoid fever and food poisoning (Bashir *et al*., 2018).

Food Safety Challenges of Street Food and Preventive Measures to Improve Consumers Safety

1. Place of preparation of street foods: Most of the vendors prepare foods either at home or at the stalls located by the roadside. Most of the stalls and retail street shops are made of polythene bags and wood. Stalls are poorly constructed. They cannot protect the street foods from dirt, dust, fumes and smoke from vehicles (Muinde and Kuria, 2005). Dust transfer various microbes that may be pathogenic if left to settle on prepared foods. To overcome food borne illness, place of preparation should be kept clean at all times and should be far away from any source of contamination. Street food stalls should be designed and constructed so that they are easily cleaned and maintained. Smart food cart should be designed. It should be at least 15 metres away from landfills/ dumping grounds and toilets. It should be far away from all sources of contamination, such as solid waste, sewage, domestic animals, insects, rodents *etc*. The food should be prepared in a clean and well-kept place sheltered from dust, sun, rain and wind and far from all sources of contamination, such as solid and liquid waste. After food preparation, disinfecting the whole floor with chlorinated water is essential. All the loose openings and fittings through which pests can come inside the areas should be sealed. Place where street food is prepared should be free from fly nuisance, rodents and stray animals. Availability of wholesome potable water improves condition of stalls under which street foods are prepared and sold.

2. Environmental surroundings of street food stalls and food waste disposal: Due to garbage and dirty waste being conspicuously close to the food stalls there is unhygienic condition created around the stalls. Also, most of the vendors do not have garbage receptacles hence they dispose their garbage just near the stalls. They throw waste water just beside the stalls making the environment polluted. *Musca domestica* is present in most of the stalls. Beside the food safety sanitation problems are waste accumulation in the streets and the congestion of waste water drains. Waste water and garbage discarded nearby attract insects, flies and other house hold rodents, facilitating carrying of food borne pathogens. The surrounding of stalls should have clean garbage disposal bins. Food waste should never be thrown on the ground to avoid attracting insects, rodents and domestic animals. Solid and liquid waste should be separated and put in covered dustbins. Solid waste should be put down in waterproof covered dustbins. Care should be taken that the bins are not allowed to overflow and are emptied thrice daily into community dustbins. All the dustbins should be covered.

3. Sanitation and hygienic of street food shop and vendor: The areas where the street food is mostly produced and sold are open to dirt and contamination. Sanitation and hygienic conditions adopted by the sellers during preparation and storage of food are insufficient. Consumption of road side ready to eat foods may pose a risk of food borne diseases as these foods are commonly contaminated by various organism from different sources. Incidence of bacterial contamination associated with various street-vended foods varies based upon the local food preparation practices, endemic microbiological load and water quality. Food handlers may contaminate the food when they are sick. Street food vendors suffering from jaundice, flu, diarrhoea, vomiting should not cook and handle food products. Street food vendors should refrain from smoking or chewing tobacco. Food vendors should wear clean clothes and keep short hair and trim their nails. Vendors must take into account that tasty food is not the only parameter customers look for and if they serve food prepared in unhygienic conditions, customers will fall sick and they will lose their customers. Poor food hygiene practices such as polluted water quality, food preparation, improper washing of food utensils, poor personal hygiene and poorly maintained surroundings generally lead to food contamination. To prevent food borne diseases proper measures need to be taken to ensure that street-foods are produced and stored hygienically. Effective application of Hazard Analysis and Critical Control Point and health and personal hygiene education among various street food vendors is required for promoting and ensuring quality street-foods.

4. Food preparation and handling of street foods by seller: Preparation and handling of food is a major part and even important part of vending. It is important to carefully choose raw materials and ingredients from reputed traders. Quality of raw materials should be checked before purchase. Raw materials should be bought from vendors who appear clean and wear clean clothes. Fresh green vegetables, good quality meat, fish, eggs and spices should be bought from those merchants who sell food materials away from public refuse dumps, public toilets, landfills and dustbins. Raw vegetables and fruits should be washed with water before preparation. Clean baskets, basin, bucket, bowl or trolley should be used for raw materials. Containers should be labelled and neatly arranged. All cooking, serving and eating utensils must be kept constantly clean. Utensils must be washed with water and detergent and then rinsed with clean water. Vegetables and meat products should be separated. Poor personal hygiene during food preparation and food handlers also contribute to the heavy load of bacteriological counts. Water is an important raw material in many street-vended operations. Food handlers should wear apron, cap and hand gloves during food preparation. Food handlers should carry out proper hand washing before cooking or handling of food and after using toilets. Their finger nails should be short, clean and without polish and hair should be covered with cap during food handling to reduce food contamination. Avoiding behaviour such as smoking, spitting, chewing, eating, coughing, sneezing over unprotected food, separation of utensils for handling raw materials, cleaning of food storage before use, covering of food and checking of expiry date of food ingredients is required. Availability of clean water for washing of hands and utensils at vending sites are important factors apart from use of proper soap or detergent.

5. Cooking and serving utensils: Food should be cooked properly and consumed immediately after cooking. Cooked food should be protected against insects, rodents and flies. Refrigerated food should be reheated properly. Food utensils used by vendors are made from plastic, metal, enamel or disposable polythene bags (Muinde and Kuria, 2005). In most of the street food stalls water for washing and rinsing the utensils is reused which is dirty water. Vendors carry water to their occupation premises in containers of 10 to 20 litre capacities. Vendors use little water for washing utensils hence hygiene is compromised. This small quantity of water is not enough for dish washing and food product preparation. Without sufficient water, hygiene and sanitary practices cannot be met. The sufficient availability of potable water should be used for drinking, food preparation and washing purpose to avoid contamination from dirty and reused water. The utensils in which the food is arranged and displayed for sale must be kept clean, properly covered and protected. Sufficient running water should be available for all washing operations.

6. Methods for packaging and storage of leftovers food: Food to take away should be wrapped in appropriate clean material but not in printed paper. Most of the vendors store their left overs in ambient temperatures, open places and open plastic containers which is quite risky because safety from contamination by pathogenic organisms is not assured and also affects the qualities of colour, texture and nutritive value of food (Muinde and Kuria, 2005). Leftover food stored by vendors should be placed in refrigerator. It is suggested that street food sellers prepare enough food for the day, so that they can sell all the food since most of them do not have good storage facilities. Spoiled leftover food should be properly disposed.

7. Storage of prepared street foods before selling: Cooked foods are kept in discrete ways before they are sold to consumers. Storing of foods in refrigerator is a very important factor. If the food sellers do not follow the storage guidelines it is going to cause a hazardous health impact on the health of customers. Displayed food should be protected from dust, insects and exhaust fumes with lids, glass panes and plastic sheeting. The traditional methods of processing and packaging, improper holding temperature and improper food storage contributes to heavy loads of bacteriological count. Prolonged time period between preparing and consuming different food items are contributing factors for outbreak of food borne diseases. Prepared street food items should be stored hygienically at appropriate temperatures and should be well protected from flies, insects, dust and other sources of contamination. If mechanical refrigeration is not available on the vending unit, then store enough ice to keep all the food cold.

8. Lack of awareness among consumers of street food: Customers should always be aware of what is being food served to them. There should be increased awareness among consumers about nutrition and hygiene aspects of street foods. It is need of the time for more awareness on food safety norms among consumers. Consumers should not buy any eatables or food products from sellers who do not keep their food in hygienic conditions. Consumers should make sure that sellers/ vendors have hand gloves on while serving food, the utensils from which food is served should be clean and the food items must be covered with lid. The responsibility also lies with the consumer, who should avoid consumption of these products if they are unaware of the conditions, it has been prepared in. There is an inadequate awareness among the consumers about their consumer rights.

9. Food Legislation to street food: Food legislation and regulatory control of street foods varies from country to country. Some countries have no specific legislation or control systems at all for street food. For street food stalls licensing/ registration systems should be compulsory (Khairuzzaman *et al*., 2014). Licence of defaulters should be cancelled. The government authority should tackle the problem by making laws that pressurises street vendors to sell hygienic food. Municipalities and food organisations/institutes can play their part by recruiting officers to examine the quality of different food. Those vendors who violate the norms should be penalised. There should be a regulatory body to keep a vigilant eye on them. The food safety department must conduct regular checking and take food samples of street vendors to ensure the quality of food. The health department should regularly visit these stalls/vends and inspect the basic infrastructure of services, potable water used, utensils and raw ingredients used for food preparation.

10. Microbiological risk assessment of street food: Microbiological risk assessment of street vended food is required from time to time, thereby ensuring that large street food consuming populations are protected against food borne illnesses. More mobile vehicle testing labs should be launched to ensure that customers relish quality street food (Bashir *et al*., 2018).

Conclusion

Street foods are foods and beverages that are sold in the street and other open public places. Consumption of street food cannot be ignored. However, care should be taken for production of hygienic and safe food for consumers. Promotion of health education, training and appropriate personal and shop hygienic practices among the street vendors is required for promoting and ensuring good quality of street foods. Street food sellers should provide adequate information about hygiene rules for food preparation, processing, servicing, and storage stages. Food hygiene regulations and food safety system should be applied. Customers must be aware about food safety and their rights.

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Early Blight Disease of Potato and its Management

Article ID: 12038

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Introduction

Potato (*Solanum tuberosum* L.) is one of the most important vegetable and non-grain food crop. India holds 2nd rank in potato production and 3rd in area under cultivation. Potato is affected by many diseases like fungal, bacterial, viral, and also parasitic nematode. In potato 16% losses in yield due to microbial diseases and out of this 70-80% due to fungal affects. Major fungal diseases in potato are early blight (*Alternaria solani*) after late blight.

Important Fungal Diseases of Potato

Diseases	Causal organisum
Late blight	*Phytophthora infestans*
Brown spot	*Alternaria alternate*
Cercospora leaf blotch	*Cercospora solani*
Charcoal rot	*Macrophomina phaseolina*
Early blight	*Alternaria solani*
Fusarium wilt	*Fusarium solani*
Black dot	*Colletotrichum coccodas*
Powdery mildew	*Erysiphe cicnoracearum*
Rhizoctonia canker	*Rhizoctonia solani*
Septoria leaf spot	*Septoria lycopersici*

Early Blight of Potato Symptoms and Management

Symptoms: Early blight appeared as small, irregular, dark brown to black spots and the size ranges from a pin point to ½ inch in diameter and also" appearance of concentric rings on older leaves (Figure 1). Brown spot lesions (Figure 2) The lesion gives a characteristic "target-spot" or "bull's eye" appearance. early blight is one the major causes of defoliation of potatoes in the North Eastern States the increased disease severity is favoured by alternating wet and dry conditions in the plant canopy (Franc, Harrison, and Lahman, 1988). The disease initially appears on the older leaves causing premature senescence and leaf area reduction (Johnson and Teng, 1990) (figure 3).

Figure 1. Early blight appeared as small, irregular, dark brown to black spots.

Figure 2. Brown spot lesions

Figure 3. leaf area reduction

Management:

a. Crop rotation
b. Selection of late season variety of potato.
c. Time to time irrigation
d. Diseased plant part destroyed properly.
e. Avoid deficiency of nitrogen and phosphorus.
f. Rotate foliar fungicides (Table 1).
g. Avoid injury and skinning during harvest.
h. Eradicate weed hosts such as hairy nightshade to reduce inoculum for future plantings.
i. Use resistant variety
j. Use bio-control agents like *Trichoderma harzianum* and *Trichoderma asperellum*.

Table 1. Some foliar fungicides to use to control early blight of potato:

Common Name	Trade Name
Mancozeb	Dithane*
Chlorothalonil	Echo*
Azoxystrobin	Quadris*

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Greenhouses for Agricultural Production

Article ID: 12039

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Introduction

Agriculture is the backbone of India's economic activity. There is very strong correlation between agricultural growth and economic prosperity. To emerge as an economic power in the world, India needs new and effective technologies in all agricultural activities to improve the productivity, profitability and sustainability. One such technology is the green house technology.

Growing plants is both an art and a science. About 95% of plants, either food crops or cash crops are grown in open field. Man has learnt how to grow plants under natural environmental conditions for long time. Some of the temperate regions where the climatic conditions are extremely adverse and no crops can be grown, man has developed methods of growing some high value crop continuously by providing protection from the excessive cold, which is called as Greenhouse Technology. So, Greenhouse Technology is the technique of providing favourable environment condition to the plants. It is rather used to protect the plants from the adverse climatic conditions such as wind, cold, precipitation, excessive radiation, excessive temperature, insects and diseases. It is also of vital importance to create an ideal micro climate around the plants. This is possible by erecting a greenhouse / glass house, where the environmental conditions are so modified that one can grow any plant in any place at any time by providing suitable environmental conditions with minimum labour.

Greenhouses are framed structures covered with transparent or translucent material large enough to grow crops under partial or fully controlled environmental conditions to get optimum growth and productivity.

Advantages of Greenhouses

1. The yield may be 10-12 times higher than that of outdoor cultivation depending upon the type of greenhouse, type of crop, environmental control facilities.
2. Reliability of crop increases under greenhouse cultivation.
3. Ideally suited for vegetables and flower crops.
4. Year-round production of floricultural crops.
5. Off-season production of vegetable and fruit crops.
6. Disease-free and genetically superior transplants can be produced continuously.
7. Efficient utilization of chemicals, pesticides to control pest and diseases.

8. Water requirement of crops very limited and easy to control.
9. Maintenance of stock plants, cultivating grafted plant-lets and micro propagated plant-lets.
10. Hardening of tissue cultured plants.
11. Production of quality produce free of blemishes.
12. Most useful in monitoring and controlling the instability of various ecological system.
13. Modern techniques of Hydroponic (Soil less culture), Aeroponics and nutrient film techniques are possible only under greenhouse cultivation.

Components of a Greenhouse

Ridge: It is the highest point of greenhouse where roofs of both sides. There is provision of ridge ventilator in some structures of greenhouse exhaust the inside hot air.

Gutter: Gutters are made on the eave of the greenhouse to drain the rainy. In single span greenhouse these are made on both sides of the wall in multi-span greenhouse there is a provision of gutter support to the gutter in between the two roofs.

Span: The distance between one gutter to another gutter is called as green span.

Purlin: Rods parallel to the roofs which connect the rafters are called as purlin. They support the greenhouse structure in horizontal direction.

Curtain Wall: Lower non-transparent part of the greenhouse wall is called curtain wall, the height of the curtain wall made by bricks and concrete is 60 cm above the ground level.

Eave: It is the line where roof and the wall of greenhouse meet.

Condensate Gutter: Small gutters situated at proper places inside the greenhouse where condensed water is stored are called condensate gutter.

Glazing Material: These are the plastics or glass sheets which cover the greenhouse structures.

Classification of Greenhouses

Greenhouse structure of various types are used for crop production. Although there are advantages in each type for a particular application, in general there is no single type greenhouse, which can be constituted as the best. Different types of greenhouses are designed to meet the specific needs. The different types of greenhouses based on shape, utility, material and construction are briefly given below:

1. Greenhouse type based on shape: For the purpose of classification, the uniqueness of cross section of the greenhouses can be considered as a factor. The commonly followed types of greenhouses based on shape are:

a. Lean to type greenhouse.
b. Even span type greenhouse.

c. Uneven span type greenhouse.
d. Ridge and furrow type.
e. Saw tooth type.
f. Quonset greenhouse.
g. Interlocking ridges and furrow type Quonset greenhouse.
h. Ground to ground greenhouse.

2. Greenhouse type based on Utility: Classification can be made depending on the functions or utilities. Of the different utilities, artificial cooling and heating are more expensive and elaborate. Hence based on this, they are classified in to two types.
a. Greenhouses for active heating.
b. Greenhouses for active cooling.

3. Greenhouse type based on construction: The type of construction predominantly is influenced by structural material, though the covering material also influence the type. Higher the span, stronger should be the material and more structural members are used to make sturdy tissues. For smaller spans, simple designs like hoops can be followed. So based on construction, greenhouses can be classified as
a) Wooden framed structure
b) Pipe framed structure
c) Truss framed structure

4. Greenhouse type based on covering material: Covering materials are the important component of the greenhouse structure. They have direct influence on greenhouse effect, inside the structure and they alter the air temperature inside. The types of frames and method of fixing also varies with covering material. Hence based on the type of covering material they may be classified as
a. Glass glazing.
b. Fibre glass reinforced plastic (FRP) glazing.
    i. Plain sheet.
    ii. Corrugated sheet.
c. Plastic film.
    i. UV stabilized LDPE film.
    ii. Silpaulin type sheet.
    iii. Net house.
d. Based on the cost of construction involved (which includes various factors mentioned from a to c)
    i. High-cost Green House
    ii. Medium cost Green House.
    iii. Low-cost Green House.

The structural requirements and the cost per unit area for different models of low-cost green houses for cultivation of vegetables are detailed below with diagrams to enable an interested entrepreneur to construct a low-cost green house on his own accord. However, the local weather conditions and the individual's necessity play a major role in the selection of the model.

Merits and Demerits of Greenhouse Coverings:

Covering	Merits	Demerits
Glass	High transmittance Low thermal expansion Resistant to heat and abrasion	Low impact resistance Very high cost
Acrylic	High transmittance Superior UV resistant And weatherability	High thermal expansion High cost Flammability
Polycarbonate	High impact resistance Wide range of service temperatures	Poor weatherability High expansion And easily scratched
Fibre reinforced plastic	Low cost and strong High impact strength Diffuses radiation	Susceptibility to UV degradation Requires PVF lamination Turns yellow

Polyethylene	Low cost Easy to install High impact resistance	Short life Low heat transfer resistance

Estimate of Material Requirement for - Simple Pipe Framed Low-Cost Green House (100 m²)

Sl. No.	Item of work / Detail of material	Requirement (Qty.)
1.	G.I. Pipe of 25 mm diameter for foundation	60 m
2.	G.I. Pipe of 15 mm diameter for arches	150 m
3.	Top M.S Flates	25 m
4.	For sides for holding mesh and UV film	120 m
Front & Backside for Purlins		
5.	M.S. 'L' ang1e 19 x 19 x 3 m for front and end	28 m
Frames and Door		
6.	Plastic beading 25 mm width	150 m
7.	UV stabilized film (200 micron)	175 m
8.	Mesh 40-60 size all round (1.15 m width)	65 m
9.	Door frame and fitting	-
10.	Hardware like Bolts and nuts, welding rods, Aluminium oxide, Painting etc.	-
11.	Earth work and concreting of foundation with 1: 3: 6	-

Estimate of Material Requirement for Construction of Low-Cost Greenhouse (500 m²)

Sl. No.	Item of work / Detail of material	Requirement (Qty.)
A	**Structural material**	
1.	G.1. Pipe of 56 mm. dia. for foundation	42 m
2.	G.1. Pipe of 50 mm. dia. for foundation posts	120 m
3.	M.S. 'L' angle 25 x 25 x 6 m for arches + top & bottom frame to fix mesh and film + for tie beams (102 lengths)	612 m
4.	Plastic beading 25 mm width	200 m
5.	Plastic pipes 25mm dia. and 19mm dia. as grippers	100.00 m
6.	Base plate for found2.tion post (50 x 50 x6 mm)	40 Nos.
7.	Welding rods	5 boxes
8.	Hardware like Bolts and nuts, welding rods, aluminium oxide, Painting etc.	L.S
B	**Cladding material**	
1.	UV stabilized film (200 Micron)	5 Bundles
2.	Rambo net 40-60 mesh (1.15 m width x 30.0 m length)	12 Bundles
C	**Construction material**	
1	Earth work excavation for foundation	4 m3
2	Sand filling for foundation and basement (optimal).	1 m3
3	Plain cement concrete for foundation	2.25 m3
4	Hollow cement bricks for foundation	3000 Nos.

Estimate of Material Requirement for Construction of Medium Cost (Single Span) Green House (300 m²)

Sl. No.	Item of work / Detail of material	Requirement (Qty.)
A	**Structural material**	
1.	G.1. Pipe of 56 mm diameter for foundation	30 m
2.	G.1. Pipe of 50 mm diameter for foundation posts	90 m
	G.1. Pipe of 38 mm. dia. for purlins and arches	205 m

3.	M.S. 'L' angle 25 x 25 x 3 m for top & bottom frame and door	150
4.	Plastic beading 25 mm width	200 m
5.	Plastic pipes 25 mm diameter and 19 mm diameter as grippers	70 m each
6.	Base plate for foundation post (50 x 50 x 6 mm diameter)	25 Nos.
7.	Welding rods	3 boxes
8.	Hardware like Bolts and nuts, welding rods, aluminium oxide, Painting etc.	L.S
B	**Cladding material**	
1.	UV stabilised film (200 Micron)	150 Kg.
C	**Cooling system (fan 7 pad)**	
1.	Fans (air flow fans)	3 Nos.
2.	Pad (9 m x 1.5 m)	1 No.
D	**Construction material**	
1.	Earth work excavation for foundation	1.25 m3
2.	Plain cement concrete for foundation (1:2:4)	1.25 m3
3.	Hollow cement bricks for foundation	1000 Nos.

Block Chain Technology in Agriculture

Article ID: 12040

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Introduction

Database is a set of information or facts. In database the information is stored in the form of tables, which helps to search the retrieve the information easily. Block chain is different from database in the way of storing information. In Block chain, data are stored in blocks and the data are chained together. The new data are updated in fresh blocks. The data are connected to previous blocks, makes the data chain together which are arranged in chronological order. The difference between spreadsheet and database is that spreadsheet application is designed for single or group of people to store and access information. But database is designed to store large amount of information that can be used to access, filter and manipulate quickly, which can be used by many users at once.

A block chain is distributed ledgers which are unchangeable, digitally recorded data in a package called blocks, where each block is connected to next block in a chain using cryptographic signature. A distributed ledger can be shared, replicated and synchronized among the users in the network. Various types of information are stored on block chain, but the common use is to transact in ledger.

Database and a Block Chain

The difference between database and block chain is that data is store in structure. Block chain holds the information in groups, known as blocks and has set of information. Blocks have some specific storage capacities and when the block is filled, chained into the previously filled block, which forms a chain of data called as “block chain”. A fresh block consists of newly added information and the new block is added into the chain once it is filled.

In database data are arranged into tables whereas in block chain, data are structured into chunks (blocks), which are chained together. All the block chains are database, but all the databases are not block chains. Each and every block has exact timestamp when it is linked to the chain. Block chain is a ledger and transaction are written and stored by all the participants.

Types of Block Chain

The types of block chain are:
1. Consortium block chain.
2. Private block chain.
3. Public block chain.

Consortium block chain: Consortium block chain is created by a group of members. Adding and verifying record to the block chain is based on the consensus mechanism with the set of nodes.

Private block chain: Private block chain is controlled by a centralized entity. Only people with permission and authentication can be a part of network and they can only add and verify the records to the block chain and it is also known as a permissioned ledger.

Public block chain: Public block chain is visible to the public; they can join or leave the block chain, can verify and append transactions to the blockchain. This is also known as permissionless block chain.

Block Chain and its Application in Agriculture

Block chain network helps the farmers to take appropriate decision in the following aspects.
1. Farm inputs
2. Financial transactions

3. Land holding
4. Demand for crops in market
5. Market price
6. Supply chain etc.

With this transparency is maintained by farmers to make effective decision. Block chain helps to get some reliable source of truth about the state of farms, contracts in agriculture, inventories and such type of information is incredibly costly. Block chain technology helps to track the origin of food and helps to create a worthy food supply chains and build a trust between producers and consumers. A trust worthy stored data with the data driven technologies helps to make farmers smarter.

Traceability

Small scale Farmers do not get correct price for their product. But in the case of block chain, it helps the farmers and customer to trace the agricultural products and skips in dealing with intermediators. Block chain gives clear idea about trending process and helps in increasing the income of farmers.

Registration of Land

Registration of land through block chain helps to maintain the record easily. This enables the farmers to contact directly with government and save from frauds.

Food Security

Block chain helps in tracing food; let the farmers and customers to track the transactions which occur at every level. Block chain helps to detect any fraud from farm till it reaches the final consumer.

Conclusion

In recent time, block chain technology is used in large number of sectors, creates opportunity for agriculture to leverage developments critical to agriculture, such as insurance, supply chain, finance, e-commerce and logistics. The block chain is very useful in reducing intermediaries (brokers /entities /processes) etc. It is very cheaper, faster and more efficient technology to collaborate directly with counter parties.

E-ISSN: 2581 - 8317

Black Scented Rice: One of the Super Food of the World

Article ID: 12041

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Introduction

Healthy Food gives a healthy lifestyle. Rice (*Oryza sativa* L.) is the most consumed cereal grain in the world, constituting the dietary staple food for more than half of its human population. In the world, rice is the second most widely consumed cereal next to wheat. Among Asian countries, India is the second largest producer after China. Black rice is used to be known as 'forbidden rice'. Ancient emperors in China hoarded black rice for the reason that they believe it would lengthen their lives and secure their thrones longer. They may have been right, as research now shows that black rice is one of the world's "superfoods." The uniqueness of the black aromatic rice of Manipur is famous for its pleasant aroma coupled with stickiness which is not common in other black rice grown in other parts of the world. *Chak-hao* is the common name of black aromatic rice in Manipur. '*Chak*' means rice and '*hao*' means tasty, so combine meaning is tasty rice. Having realized the inherent unique properties, good scope for commercial cultivation and value addition of its products for a profitable agro-business have already been envisioned with its gaining importance and demands from around the globe. It is considered to be rice variety with a higher vitamin and mineral content than both white and brown rice. Black aromatic rice owes its colour to powerful natural purplish-black colouring pigments called anthocyanins which boast an impressive antioxidant activity adding to the health benefits of this rice variety. In addition to being a good source of vitamins E, fibre and protein, black rice is shown to reduce inflammation levels in the body. According to findings, black rice consumption contributes to the prevention and management of ailments such as atherosclerosis, diabetes, Alzheimer's disease, hypertension, high cholesterol levels, arthritis, allergies, aging signs, and even cancer.

Nutritional Facts

The purplish-blackish pigments are antioxidants which are known as anthocyanin the same ones which are in blueberries, considered to be one of the richest sources of antioxidants, which is known for high fiber, minerals and vitamins than the regular rice varieties. Black rice, has been shown to possess bioactive properties, and rice bran contains high levels of several antioxidant compounds. Relatively high levels of free polyphenols and flavonoids found in bran and lower levels were found in endosperm. These rice varieties showed significant differences and higher 1000 kernel grain weight, 1000 grain volume, grain length, breadth, length breadth ratio and bulk density was observed in black rice varieties. The amylose content was significantly lower in black rice varieties. Evaluation of chemical composition of the rice varieties showed higher protein content (11.4%), fat content (3.2%), crude fiber (1.64%) in Burma black rice, zinc content (6.20 mg/100 g) in black rice (Chak-hao amubi), manganese content (2.56%) in black rice (Chak-hao- *Poireiton*). Phytonutrient contents showed higher content of polyphenol (62.33 mg gallic acid equivalent per 100 g), phytate (27.36 mg per g) and antioxidant activity (72.52%) by DPPH (2, 2-diphenyl-1 picryl-hydrazyl) assay in black rice chak-hao *Poireiton*. Anthocyanins can be used in the food industry as synthetic dye replacements. Black rice is a variety of pigmented rice. It contains numerous nutritional and bioactive components, including essential amino acids, functional lipids, dietary fibre, vitamins, minerals, anthocyanins, phenolic compounds, γ-oryzanols, tocopherols, tocotrienols, phytosterols and phytic acid. The major anthocyanin compositions of the two black scented rice cultivars (Chak-hao *Poireiton and* Chak-hao *Amubi*) were studied using HPLC. Four main anthocyanins, i.e., delphinidin 3-galactoside, delphinidin 3-arabinoside, cyanidin 3-galactoside and cyanidin 3-glucoside were identified in Chak-hao *Poireiton* while three main anthocyanins, delphinidin 3-galactoside, delphinidin 3-arabinoside and cyanidin 3-galactoside were identified in Chak-hao *Amubi*. In both the cultivars, delphinidin 3-galactoside is the most predominant anthocyanin. The total monomeric anthocyanin content and total phenolics were measured using a modified pH differential method and modified Folin-Ciocalteu method, respectively. The total anthocyanin content in Chak-hao *Poireiton* was found to be 740 mg/kg and Chak-hao *Amubi* was 692 mg cyanidin 3-glucoside/kg of dried powder sample. And the total phenolic content was 577 and

500 mg/100 g of the dried powder sample as Gallic acid equivalent in Chak-hao *Poireiton and* Chak-hao *Amubi*, respectively. The anthocyanin extract showed strong antioxidant activity by DPPH assay, the highest scavenging activity of Chak-hao *Poireiton and* Chak-hao *Amubi were* 70.28 % and 69.73 %, respectively. From the study it can be suggested that supplementation of the black scented rice in the diet will have a great impact on human health. The rich anthocyanin and phenolic help to protect the plant from rice diseases and pests.

Nutritional Value Per 100 g of Black Aromatic Rice

Total crude protein	12.15%
Total carbohydrate	72.43%
Amylose	8.27%
Total fat	4.8%
Ash	1.57%
Crude fibre	0.71%

Mineral Contents

Calcium	24.06 mg
Magnesium	58.46 mg
Manganese	1.03 mg
Copper	4.30 mg
Cobalt	0.43 mg
Iron	23.34 mg
Total anthocyanin	69.2-74.0 mg (cyanidin 3-glucoside)
Total phenolic	500 and 577 mg (Gallic acid equivalent)

Utility and Value-Addition

Chak-hao is consumed mainly after being cooked as rice or kheer. Some of the value-added product that can be prepared are powder, suji (flour), syrup, chocolate, beer, wine, cake, bread, flattened rice, paratha, ladoo, other sweetened food and cosmetic items. Chak-hao rice extracts is a potential source of anti-oxidative phyto-chemicals and useful ingredient for nutraceuticals or functional food products and natural colourants rather than the toxic synthetic.

Geographical Indication Tag (GI)

Chak-hao, the aromatic black rice of Manipur being cultivated for centuries with traditional practices, was recently awarded the Geographical Indication (GI) tag. The application for chak-hao was filed by the Consortium of Producers of Chak-hao (Black Rice), Manipur, and the research and process was facilitated by the Department of Agriculture of the Government of Manipur, the North Eastern Regional Agricultural Marketing Corporation Limited and the Union Ministry of Development of North Eastern India.

Nutritional Comparison Between White, Brown and Black Rice

Black rice	White rice	Brown rice
Ingredients: Medium Grain Black Rice	Ingredients: Milled Rice	Ingredients: Water, Partially Milled Brown Rice.
Energy 356 kcal	Energy 344 kcal	Energy 162 kcal
Protein 8.89 g	Protein 6.67g	Protein 3.33g
Total lipid (fat) 3.33g	Total lipid (fat) 0g	Total lipid (fat) 1.19g
Carbohydrate, by difference 75.56g	Carbohydrate, by difference 77.78g	Carbohydrate, by difference 34.29g
Fiber, total dietary 2.2g	Fiber, total dietary 0g	Fiber, total dietary 1.4g
Sugars, total including NLEA 0g	Fiber, total dietary 1.4g	Sugars, total including NLEA 0g
Calcium, Ca 0mg	Calcium, Ca 0mg	Calcium Ca 10mg
Iron, Fe 2.4mg	Iron, Fe 0.8mg	Iron, Fe 0.86mg

Sodium, Na 0mg	Sodium, Na 0mg	Sodium, Na 0mg
Vitamin C, total ascorbic acid 0mg	Vitamin C, total ascorbic acid 0mg	Vitamin D (D2 + D3), International Units 0 IU
Fatty acids, total saturated 0g	Fatty acids, total saturated 0g	Fatty acids, total trans 0g
Cholesterol 0 mg	-	-

Conclusion

Because of having so many desirable characters of a healthy food, Black Aromatic rice should be incorporated in the daily life every Indian family. Seeing the other side, high cost and colour preference may be the lacuna for the popularization of black aromatic rice. Doctors are recommending that for a balanced diet, black aromatic rice should be consumed at least once in a week.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Intellectual Property Rights (IPR)

Article ID: 12042

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Abstract

This article is about the Intellectual Property Rights (IPR), which includes Patents, Geographical indications, Copy rights, Industrial designs, Trademarks and Plant verities and farmers rights etc. It is not only in the interest of the individual but country and society at large that scientific inventions, new technologies and achievements are protected so that the respective innovators, designers and other professionals can gain rewards which they deserve. Knowledge and information, economically exploited as intellectual property are replacing the more traditional material elements of production as the primary engine of economic growth. It is influenced by the ingenuity, creativity, and innovative ability of a nation. Converting these resources into tangible economic assets requires an effective and efficient intellectual property system.

Introduction

Intellectual property or describes the idea, innovation, technology, artwork, music, literature that are intangible when first created become valuable in tangible form as a product.IPR is the right of inventor to derive economic benefits from his innovation.Intellectual property right is a creation at human mind.If you have an intellectual property right over any at your work as ideas, other need to take your permission before using it. Otherwise you can initiates legal action against such persons.We can bring, sell, mortgage the license exchange or free.

History of Intellectual Property Rights

1856	Act of protection of invention based on the British patent law of 1852.
1872	The patents and designs protection act.
1883	The protection of inventions act.
1888	The invention and designs act.
1911	The Indian patents and designs act.
1957	The copy right act amended in 1999.
1958	Indian trade and merchandize act.
1970	Indian patents act amended twice in march 1999 and in December 2003, 2005 amendment.
1999	The geographical indications of goods registration and protection act., Amendment 2003
2000	The designs act.2000, amendment 2003
2001	The protection of plant varieties and farmers right act (PPV and FR act 2001)

Legislation of Intellectual Property Act

1. The patent act 1970.
2. Product patent.
3. Patent term of 20 years.
4. Public health safe guards.
5. Protection to Traditional knowledge.
6. The trade mark act 1999 amendment act 1958.
7. Service marks and collective marks.
8. Term increased from 7 years to 10 years
9. The designs act 2000 amendment 2003.
10. The geographical indications act 1999 registration and protection.

11. The copy right act 1957
12. The biodiversity act 2001.
13. The layouts and integrated circuits act 2000.
14. Patents amendment ordinance was in issued in 1994 and become patent act 1999.
15. Patents (second amendment) bill 1999 was now become patent amendment act 2002.
16. Patents amendment act 2005 product regime launched.

Some of the Important Feature of the Patent Amendment Act 2005 are

1. Areas of Patentability (and exclusion)- sec3, clause g omitted, in clause 'b' and 'c' certain words omitted, additional clauses 'j', 'k', 'l', 'm' 'n' 'o' and 'p' added, 'k' further amended

2. Product / Process Patent – sec 5 provided – only process patent in certain category, Article 27.1 of TRIPS – product patent in all fields of technology, sec 5 – chemical process – includes biochemical, biotechnological and microbiological process, Now omitted

3. Patent Term- 20 years for all process and product patents, sec 53(1) – term of every patent – not expired, not cease to have effect -20 years

4. Contents of specification- sec 10, sub clause 4(d) - an abstract, requirement of making a deposit of the material, sub-clause 10.5 – a single inventive concept

5. Examination and Publication- new sec 11A and 11B, sec 11A – all applications – not be opened till 18 months, sec 11-b: examination on request, within 48 months, now 36 months.

6. Prohibition to apply for Patent outside India. - sec 39 – not to make an application outside India – Defense, atomic energy, apply in India, seek clearance

7. Rights over importation. - right to make, use, exercise, sell or distribute – include importation

8. Compulsory Licensing- sec83,84,85 and 89-95, sec 92 – grant of license in national emergency, extreme urgency –public health crisis- includes procedures relating to AIDS and HIV, removal of three-year restriction - CL.

9. Use by Government and Government Agency – sec 47, sec 99-103 – various situations, sub sec (2) of sec 99 -omitted

10. Burden of proof concerning infringement –sec 104(A) – inserted, infringement of process patent – defendant – establishes non-infringement.

11. License of Right- sec 86-89 of patent Act 1970, provisions of License of Rights - dropped.

12. Appellate Board – sec 116 the appellate Board established u/s 83 of Trade Mark Act 1999 – the appellate Board – patent act appeal to appellate Board – decision, order or direction of controller, otherwise earlier was – High Court.

13. Unauthorized claims of Patent Rights – sec 120 – wrong representation about patented in India or patent application, fine increased from 500/- to 10,000/-., Now Rs. 1,00,000/-

14. Other Amendments- sec 48 –prevent third party with no consent, sec 107(A) (a) – protection of biodiversity and traditional knowledge.

Forms of IPR

1. Patents.
2. Copy rights.
3. Trade marks.
4. Geographical indications.
5. Industrial designs.
6. Plant verities and farmers rights act.

Patents

Patents are rights related to new inventions. The right is conferred on persons who invent any new machines process, article of manufacture or composition of matter biological discoveries etc. The person who receives a patent for his inventions has an exclusive right to control to others for making, using, selling or distributing the patented invention without permission. The time limit of patent is 20 years from the date of filling the applications.

What Does Patents System Do?

1. It encourages RESEARCH.
2. Induces an inventor to disclose his inventions instead of keeping them as secret.
3. It Provides inducement for capital investment encouraging technological development.
4. It encourages establishment of new industries.

Who can File Patent Application in India [Section 6 and 134]?

Either alone or jointly:

1. By any person claiming to be true and first inventor(s)
2. By any person being the assignee of person claiming to be true and first inventor(s)
3. By the legal representative of any deceased person who Can immediately after his death is entitled to make such Application.

Advantages of A Patent to the Public

1. Knowledge of invention adds to the scientific background forming base for further research.
2. The patent granted for limited for limited period hence scope for new one to come earliest.
3. Patentee eligible to take legal action under any mis utilization.
4. The patentee has an exclusive right to make use exercises sell or distribute an invented article or process.

Geographical Indications

Geographical indication means an indication which identifies goods as agricultural goods natural goods or manufacturer goods as originating or manufacture in the territory of a country or a region or locality of that territory. The registration for geographical indications is 10 years. Examples of geographical indications in India are Basmati rice, Darjeeling tea, solapurechaddar, Mysore silk, Kulu shawl etc.

Geographical Indications in India

Sr.no	Product	State
1.	Balrampuram fine cotton saries	Kerla
2.	Paithanisaries	Maharashtra
3.	Sambalpursaries	Orissa
4.	Bomkaisaries and fabrics	Orissa
5.	Chanderimusalinsaries	Madhya Pradesh
6.	Maheshwarsaries in silk texture	Madhya Pradesh
7.	Patella saries	Gujarat
8.	Lucknowchiken craft	UttarPradesh
9.	varanisisaries and brocades	Uttarpradesh
10.	Balucharisaries and dress materials	West Bengal

Benefits of Geographical Indications

1. It confers legal protection to geographical indications in India.
2. It prevents unauthorized use of a registered geographical Indication by others.
3. It boosted exports of Indian geographical indications by providing legal protection.
4. It promotes economic prosperity of producers.

Copyrights

Copy rights gives the creators of a wide range of material such as literature, art, music, sound recording, films and broadcasts. economic rights enable them to control use of their material in a number of ways, such as by making copies, issuing copies to public, performing in public, broadcasting and use online. Purpose of copy right is to allow to creators to gain economic regards for their efforts and so encourage future creativity and development of new material which benefits us all. Copy rights applies to the original work, website and internet written work including software's and data bases, theatre music artistic work including photograph spoken work performance, Tv. And films. It provides protection for a specific period .it is lifetime of creator and 60 years after his/her death. It does not prevent another person from using their idea or information contain in a copy right material.

Advantages of Copyright

1. Copyright help in protecting the original published / unpublished work.
2. Copyright holder can enjoy following rights –one can use, reuse, reproduce the copies and can sell the copies.
3. One can import or export whole or part of work.
4. One is free to create any derivative work.
5. One can publicly demonstrate its work.
6. One can sell or pass its rights to another person.

Trademark

A trademark is any sign which can distinguish the goods of one trader from those of another. sign includes words logos pictures or combination of these. A trademark is used as a marketing tool so that customers can recognize a product of a particular trader. The term trade mark is for 10 years. To register a trademark, the mark must be distinctive and not descriptive or contrary to law or not identical or similar any earlier mark. Geographical names connected with reputation or quality of the goods for which registration not to be adopted.

Advantages of Trademarks

1. The trademark gives exclusive rights to the owner.
2. At the time of any infringement, the owner can take upon the case in the court.
3. Trademark provides the guarantee for the unchanged quality.
4. Helps in creating and advertising
5. The products and services in public.

Industrial Designs

1. The protection you receive is only for the appearance of the article and not how it works.
2. Design registration is intended to protect designs which have an industrial or commercial use.
3. Duration of protection is initially for 10 years and extendable for another term of 5 years.
4. Designs of stamps, labels, tokens, cards, cartoons, or parts of an article not sold separately, cannot be registered.

Benefits of Industrial Designs

1. Registration of a design confers upon the registered proprietor the exclusive right to apply a design to the article in a class in which the design has been registered.
2. Industrial designs are of great commercial value because shape or configuration of the article can often be a great selling point. When companies are competing at equal price and functionality, design is the only differential that matters for achieving market advantage and competitiveness.

Protection of Plant Varieties (PPV)

Objectives of the PBR (PPV and FR Act 2001):

1. To provide protection to plant varieties.
2. To protect right of the farmers in their contribution made and making available plant genetic resources for the development of new varieties.
3. To protect plant breeders' rights to stimulate investment for research and development both in public and private sector, for development of new varieties.
4. To promote growth of seed industry to avail high quality seed.

Period of Protection

1. After registration, it is 9 years for tree and vines.

2. And for crop variety it is 6 years.
3. The period of validity should be may renewed for the maximum period of.
4. For tree and vines: 18-20 years.
5. For other crops: 15 years.
6. For extent varieties: 15 years.

Conclusion

From the above article it is concluded that the IPRs pervades all sectors of economy and is increasingly becoming important for ensuring competitiveness of the enterprises. The number of domestic filings is very less and major applications are from foreign nationals which is a cause of concern since it shows that domestic R&D activities are not given enough boost. Hence steps should be taken to encourage original research activities which will help develop India and mankind.

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3. www.uspto.gov/patft (US patent database).
4. www.wipo.int (International patent database).

Success Story on Enhancing Farm Income through Adoption of Improved Dairy Technologies

Article ID: 12043

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Introduction

In Sehore district majority of the farmers are small or marginal. Due to fragmentation of land holdings, even after adoption of improved agricultural technology and practices, their economy condition has not improved. In general, the crop husbandry alone under the vagaries of nature cannot improve the living standard of the rural areas. Livestock forms an integral and sustainable part of rural household system. Dairy entrepreneur generates cash income to farmers almost on a daily basis, besides being a source of liquidity and insurance against crop failure.

Brief Profile

Name	Sri Meghraj Mewada
Address	Village- Golukhedi, Block – Ichhawar, District- Sehore (M.P.)
Mobile No.	9770081863
Age	50 years
Education	10th
Land holding	15 Acre
Farming Experience	By birth
Cropping pattern	Soybean- Wheat Soybean –Chickpea Sorghum – Barseem – Maize
Live Stock	Buffalo (Murrah) – 11 Cows (HF cross) – 04 Heifers – 08

Description of Entrepreneurship

Village Golukhedi is situated 14 Kms. from Tehsil – Ichhawar and 21 Kms. from Krishi Vigyan Kendra. Mr. Meghraj was participating in Krishi Vigyan Kendra activity & contact to KVK scientist. He was inspired with thought of KVK scientist & established improved dairy. He was established a modern dairy & focus on balance feeding with round the year green fodder, azolla, mineral mixture and concentrate feed. He was also focus on hosing management, breed improvement, Vaccination & Deworming of Animals. Now he obtained Average 78-liter Milk Production per day Round the year and 8 Heifers in a year for sale. He was motivating for organic farming. He Prepare biogas & 100 Percent dung are use as manure in crops. He observed the impact of organic Manure in crops, the crops growth is good & enhance the productivity & reduce the Cost of cultivation. Mr. Meghraj Mewada get success and Satisfy with the dairy farming. Farmers of Golukhedi and nearby also inspired by Mr. Meghraj Mewada. He got reorganization in local area and well-known farmers for dairy management.

E-ISSN: 2581 - 8317

Out Come of Entrepreneurship

Mr. Mr. Meghraj Mewada was established improved dairy with regular contact with Krishi Vigyan Kendra and observed more profit with adoption of latest technologies in dairy farming. He also gains organic manure which is used in crop & they found reduce the cost of cultivation in crop & enhance the net profit.

Economic Impact

Year	No. of Milch Animals	Milk Production lit/year	Heifer Sale/year	Gross income (Rs./Year)	Expenditure (Rs./Year)	Net Income (Rs./Year)	B:C Ratio
2013	11	20075	4	701875	421125	280750	1.66
2014	13	22995	6	874875	437438	437437	1.99
2015	14	25550	7	988750	444938	543812	2.22
2016	14	26250	8	1027500	441825	585675	2.33
2017	15	28480	8	1094400	437760	656640	2.50

Conclusion

Dairy farming gives employment to the farmers and provides additional income to the rural communities. The success of Mr. Meghraj Mewada has also motivated many farmers. The success of the scientific dairy farming needs to be popularized to address the issues for enhancing household income and socio-economic status of farming community.





E-ISSN: 2581 - 8317

Generation of Biogas from Biodegradabele Kitchen Waste

Article ID: 12044

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Summary

In the world of today one of the burning problems faced were management of all the wastes and energy crisis. Increase in waste due to increasing population and urbanisation have led to fossil fuel depletion. All the problems related to waste and energy can be solved by biogas production from kitchen waste.

Introduction

India is second most populous nation in the world having 3 billion residents generating 1.2kg/capita/day of Muncipal Solid Waste (MSW) and estimated that by 2025, this number will increase to 4.3 billion urban residents with 1.42 kg/capita/day of MSW (Hoornweg, 2012).

Biogas can be generated from different biodegradable waste but among them kitchen waste is most suitable compared to other wastes like food waste, manure, agricultural and forestry waste etc. due to more biodegradability, calorific value and nutritive value to microbes, which will decrease our need on fossil fuels.

Kitchen waste consists of fruit and vegetable peelings also food waste. For the production of biogas from kitchen waste it consists of following components.

Slurry Preparation Tank

The kitchen waste is converted into slurry with 45-50% solids, 10% cow dung and 50% water (Reddy *et al.*, 2003).

Digester

The digester is huge vessel made of hard plastic to bring about chemical and biological reactions. The slurry is added in the digester and anerobic (process) digestion takes place and producing mainly a mixture of gases like methane, carbon dioxide and other gases. Anaerobic digestion consists of four phases.

Hydrolysis

In hydrolysis large polymers like carbohydrates, proteins and fats present in the slurry are converted into smaller particles like amino acids, fatty acids and simple sugars by breaking into small molecules by fermentative and hydrolytic bacteria.

Acidogenesis

After hydrolysis, amino acids and sugars present in slurry are further broken down to H_2, CO_2, H_2S, shorter volatile fatty acids, carbonic acids, alcohols, as well as trace amounts of other by-products by acidogenic bacteria by creating acidic environment in the digestive tank.

Acetogenesis

Organic acids are converted to acetic acid, along with additional ammonia, hydrogen and carbon dioxide by acetogenic bacteria.

Methanogenesis

It is the final stage in anaerobic process. Methane is produced from methanogens from the final products of acetogenesis also from intermediate products of hydrolysis and acidogenesis.

Valves

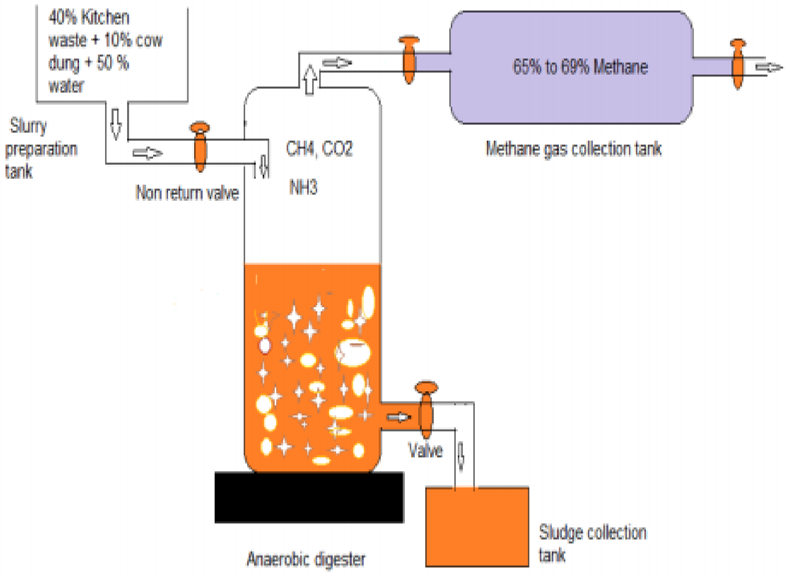
It is a device which regulate the flow of a slurries within the anerobic digester, which is used for production of biogas.

Gas Purifier

After generation of biogas from digester, it consists of carbon dioxide (CO_2), hydrogen sulphide (H_2S), and methane (CH_4). Gas purification is done by removing H_2S and CO_2 gases by passing it through water.

Pressure Gauge

To measure the digester pressure, pressure gauge is used.



(Reddy *et al.*, 2003). Anerobic digester experimentation unit model

Factors Affecting Biogas Production

Temperature: For optimum biogas production the temperature should be of between 35-38˚C. The fall in biogas production starts at 20 ˚C and stops at temperature of 10 ˚C (Rai *et al.*, 20011).

pH: For optimum biogas production the ideal pH value should be in between 7 to 7.5. In this pH the microorganisms will be very active and biodigestion will be very efficient. The pH of raw material should not be acidic which ranges from 4 and 6 also it should not be alkaline which is in between 9 and 10 because by the adding raw material in the digester causes an imbalance in the bacterial growth (Rai *et al.*, 2008).

Seeding: In cow dung, acid and methane formers are present but they are not in large number so seeding should be done because acid formers multiply fast and increase in number whereas methane formers reproduce and multiply slowly. Therefore, artificial seeding should be done to increase methane formers in the digested sludge.

Loading rate: It is the amount of raw material (usually kg of volatile solid per day per unit volume) added in the digester should be optimum (Rai *et al.*,2011). When the too much of raw material is loaded in the digester accumulation of acids takes place and fermentation stops.

Agitation: Proper stirring of the slurry in the digester is necessary so that bacteria will get all essential nutrients from supply of food because bacteria in the digester have very limited reach to their food. Stirring slowly improves the fermentation, however stirring fastly retards the digestion.

Uniform feeding: Feeding of raw material in the digester should be uniform that is, the digester should be fed with same quantity and quality so that microorganisms will keep the organic solid concentration constant in all times.

Total solid content: Mixing the cow dung in a proportion of 1:1(by weight) so that to bring solid content (8-10%). The raw cow dung contains 80-82% of moisture. The balanced 18-20% is termed as total solids.

The adjustment of total solid content helps in bidigesting the material at the faster rate and also in deciding the mixing of the various feed stocks in biogas digester (Rai *et al*., 2008).

Carbon Nitrogen ratio of input material: The optimum Carbon-Nitrogen ratio that best suits for maximum microbiological activity is 30:1. (Rai *et al*., 2008). In the raw material if there is excessive carbon, then nitrogen will be used up first and bacteria does not make use of carbon and breaking of raw organic matter will be sufficiently less and makes the digester to slow down the process and comes to stop. Also, if there is excessive usage of carbon the process soon will get exhausted and fermentation stops. Carbon and nitrogen content should be in proper proportion to get maximum biogas production.

Pressure: Some work conducted at National Environmental, Engineering Research Institute (NEERI) Nagpur and other places indicated that the pressure on the surface of slurry also affects the fermentation. It has been reported to be better at lower pressure. (Rai *et al*., 2008).

Retention time: The amount of time spent for the feed material in the digester for biogas generation is known as retention period. Normal value of the retention period is between 30 and 45 days and in some cases 60 days (Rai *et al*., 2008).

Conclusion

In most of the locations like cities, hostels, houses, agricultural market yards, fruits and vegetable market, huge amount of biodegradable waste are generated. Biodegradable waste composition varies according to their living conditions from urbal to rural. Disposal of these waste in dumps causes public health threats and diseases such as malaria, cholera, typhoid etc also it emits unpleasant odour and methane which is a major greenhouse gas contributing to global warming. Biogas generation from biodegradable waste helps to reduce land filling cost, surface and groundwater contamination, air pollution from burning waste and carbon emission. Thus, provides more flexible overall waste management with little capital and operating costs.

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Scientific Cultivation of Makhana

Article ID: 12046

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Introduction

Euryale ferox salisb is an important aquatic crop, belong to family Nymphaeaceae is commonly known as Makhana, Gorgon nut or Fox nut,and grown in stagnant perennial water bodies like ponds, land depression, swamps and ditches. Makhana seeds are also known as black diamond.

Bihar is the leading producer of makhana accounting for more than 85% of the total production of India. Madhubani, Darbhanga, Sitamarhi, saharsa, Katihar, Purnia, supaul, kishanganj and Araria districts are the major producers of Makhana in the State. Area under Makhana cultivation is about 13000 ha.

Makhana has floating leaf and emergent macrophyte. The leaves are orbicular, floating and glabrous, green and corrugated above and deep purple beneath, supported by stout, porous and prickly ribs. The chemical constituents of the popped kernels (g/100 g) are 12.8 g moisture,76.9 g carbohydrate,9.7g proteins,0.1 g fat,0.5g total minerals,0.02 g calcium,0.9 g phosphorus and 0.0014 g iron which makes it comparable to dry fruits such as almond, walnut, cashew nut and coconut. Makhana is recommended for treatment of diseases regarding respiratory, circulatory, digestive, excretory and reproductive systems.

Cultivation of makhana has immense potential for enhancing the economic status of farmers. Makhana cultivation and production should be recognised as an industry. The diversification from high volume low value crop to low volume high value crop may also increase farmers income as well as job opportunity for rural youth. In such a scenario, makhana could be saviour for the farmers of this region, with huge abundance of low land areas and relatively higher rainfall during kharif season.

Crop Cultivation

Makhana is cultivated in perennial water bodies/ponds having water depth of 4-6 ft or in field system having depth of 1-2 ft.

Pond System

It is the traditional system of makhana cultivation. Seed sowing is not required since left over seeds of the previous crop serve as a planting material of subsequent crop. For direct sowing requirement of seed is 80-90 kg/ha. When Plantlets come out to the upper surface of water. At this stage optimum distance of 1x1 m is maintained by the thinning of extra plants.

Field System

This system of makhana cultivation has been standardized by ICAR Research Complex for Eastern Region. Makhana cultivation is carried out in agricultural fields at a water depth of 1 ft. This system is very easy to operate and provides opportunities to cultivate singhara and cereals in same piece of land.

For sowing, the field is well prepared by two-three deep ploughing. Before ploughing, for proper nourishment of seedlings, fertilizers@100:60:40/ha, respectively, of N, P and K is applied. The field is filled with water up to the 1.5 ft height of bund and the seeds are sown in the month of December. An amount of 20-25 kg of healthy seeds is broadcasted uniformly in the entire field. For transplanting in one hectare area, about 500m^2 of nursery is found to be sufficient. By the end of March seedlings are ready for transplanting.

Harvesting

The flowering and fruiting start from the month of May and it continued up to October-November. Upon Maturity, the fruits start rupturing and floating on the upper surface of the water. Harvesting refers to the collection of scattered seeds from bottom of pond/field. The field system takes lesser time and gives higher yield as compared to traditional method of pond system.

Cleaning and Storage

The collected seeds are put in a crescent shaped container known as Gaanja which is shaken repeatedly by touching water surface, until all the seeds get cleaned. After proper cleaning seeds are put in gunny bags. The seed yield in Pond system is 1.4-2.2 t/ ha, while in field system the yield potential has been recorded to be 2.6- 3 t/ha.

Post-Harvest Management

The popping process is highly skilled, tedious, time consuming. Post-harvest technology involves sun drying, size grading, pre-heating and tempering and popping, polishing, grading and packaging.

Sun Drying and Size Grading

The moisture content of seeds is reduced to an extent of 25% (w. b.) with the help of sun drying. The entire gradation process requires the sieves of 7 different sizes, marked with No.1-7. while no.1 devise has the largest diameter of pores (1.2 cm), no.7 has the least diameter (0.4 cm). Gradation starts by using No.1 sieve and ends with sieve 7. The entire process is operated manually.

Pre-Heating and Tempering

Sun -dried seeds are heated in earthen pitcher by placing them over the fire and stirring them continuously. The storage of pre-heated seeds for duration of 48-72 hrs at the ambient condition is known as the tempering of the seeds.

Roasting and Popping

Pre-heated and tempered seeds are taken and roasted in a cast iron pan in single layer over the fire at 290-340^0 c surface temperature with continuous stirring. The roasted seeds are scooped quickly on a hard surface and beaten by the wooden hammer.

Polishing and Grading

Makhana are polished by rubbing action among them in a basket made of bamboo splits. This operation facilitates more whiteness and lusture to makhana. The popped makhana is generally graded in two grades at the producer level-lawa and thurri. The lawa is swollen and white with reddish spot, thurri is semi-popped, hard and reddish in colour.

Packaging and Storage

Makhana is less perishable. Therefore, ordinary gunny bags for local markets and gunny bags with polythene lining are used for distant markets. Makhana can be easily stored under ordinary storage conditions for long periods.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Biofertilizers are Future for the Sustainable Crop Production

Article ID: 12047

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Introduction

Indiscriminate use of synthetic fertilizers has led to pollution and contamination of soil and water basins. This has resulted in soil being deprived of essential plant nutrients and organic matter. It has led to depletion of beneficial micro-organisms and insects indirectly reducing soil fertility and making crops more prone to diseases. It is estimated that by 2020, to achieve the targeted production of 321 million tons of food grain, the requirement of nutrient will be 28.8 million tons, while their availability will be only 21.6 million tons being a deficit of about 7.2 million tons, thus depleting feedstock/fossil fuels (energy crisis) and increasing cost of fertilizers which would be unaffordable to small and marginal farmers, thus intensifying the depleting levels of soil fertility due to widening gap between nutrient removal and supplies. Biofertilizers are the products containing one or more species of microorganisms which have the ability to mobilize nutritionally important elements from non-usable to usable form through biological processes such as nitrogen fixation, phosphate solubilization, excretion of plant growth promoting substances or cellulose and biodegradation in soil, compost and other environments.

The Need of the Hour in Agriculture

At present times, there is a growing concern about environmental hazards and threats to sustainable agriculture. In view of the above stated facts, the long-term use of bio-fertilizers proves to be economical, eco-friendly, more efficient, productive and accessible to marginal and small farmers over chemical fertilizers. The need for the use of biofertilizer thus arises primarily for two reasons. First, because increase in the use of fertilizers leads to increased crop productivity, second, because increased usage of chemical fertilizer leads to damage in soil texture and raises other environmental problems.

Benefits of Bio Fertilizers

Bio-fertilizers are living microorganisms of bacterial, fungal and algal origin. Their mode of action differs and can be applied alone or in combination.

1. Biofertilizers fix atmospheric nitrogen in the soil and root nodules of legume crops and make it available to the plant.
2. They solubilize the insoluble forms of phosphates like tricalcium, iron and aluminum phosphates into available forms.
3. They produce hormones and anti-metabolites which promote root growth.
4. They decompose organic matter and help in mineralization in soil.
5. When applied to seed or soil, biofertilizers increase the availability of nutrients and improve the yield by 10 to 25% without adversely affecting the soil and environment.

Types of Biofertilizers

Based on type of nutrient available:

a. **For Nitrogen**
    i. Rhizobium for legume crops.
    ii. Azotobacter/Azospirillum for non-legume crops.
    iii. Acetobacter for sugarcane only.
    iv. Blue –Green Algae (BGA) and Azolla for low land paddy.

b. **For Phosphorous:** Phosphatika for all crops to be applied with Rhizobium, Azotobacter, Azospirillum and Acetobacter

c. For enriched compost

i. Cellulolytic fungal culture.

ii. Phosphotika and Azotobacter culture.

	
Blue Green Algae	**Azolla**

Application of Biofertilizers to Crops

Seed treatment: Each packet (200g) of inoculant is mixed with 200 ml of rice gruel or jaggery solution. The seeds required for one hectre are mixed in the slurry so as to have uniform coating of the inoculants over the seeds and then shade dried for 30 minutes. The treated seeds should be used within 24 hous. One packet of inoculant is sufficient to treat to 10 kg seeds. Rhizobium, Azospirillum, Azotobacter and Phosphobacteria are applied as seed treatment.

Seedling root dip: This method is used for transplanted crops. Five packets (1.0 kg) of the inoculants are required for one ha and mixed with 40 litres of water. The root portion of the seedlings is dipped in the solutions for 5 to 10 minutes and then transplanted. Azospirillum is used for seedling root dip particularly for rice.

Soil treatment: 4 kg each of the recommended biofertilizers are mixed in 200 kg of compost and kept overnight. This mixture is incorporated in the soil at the time of sowing or planting.

Tips to Get Good Response to Biofertilizer Application

1. Biofertilizer product must contain good effective strain in appropriate population and should be free from contaminating microorganisms.
2. Select right combination of biofertilizers and use before expiry date.
3. Use suggested method of application and apply at appropriate time as per the information provided on the label.
4. For seed treatment adequate adhesive should be used for better results.
5. For problematic soils use corrective methods like lime or gypsum pelleting of seeds or correction of soil pH by use of lime.
6. Ensure the supply of phosphorus and other nutrients.

Personal Opinion

Biofertilizers being essential components of organic farming play a vital role in maintaining long term soil fertility and sustainability by fixing atmospheric di-nitrogen, mobilizing fixed macro and micro nutrients in the soil into forms available to plants.

Conclusion

Currently there is a gap of ten million tons of plant nutrients between removal of crops and supply through chemical fertilizers. In context of both the cost and environmental impact of chemical fertilizers, excessive reliance on chemical fertilizers is not practicable in the long run because of the cost, both in domestic resources and foreign exchange involved in setting up of fertilizer plants and sustaining the production. In this context, biofertilizers would be the viable option for farmers to increase productivity per unit area.

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Role of Chitosan in Mucosal Drug Delivery System

Article ID: 12048

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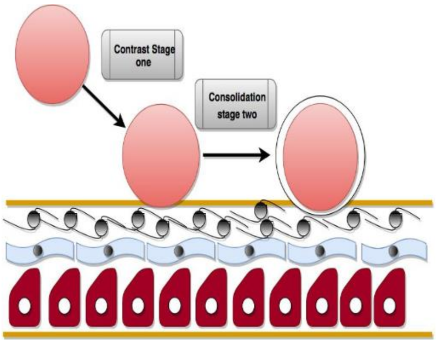
Mucosal Drug Delivery System (MDDS)

The moist, inner lining of some organs and body cavities is called Mucosa. It is composed of epithelium cells and thin connective tissue. Mucus is a slippery aqueous secretion produced by cells of mucous glands and covering mucous membranes. Mucosal Drug Delivery System interacts with mucus layer covering the mucosal epithelial surface & mucin molecules & increase the residence time of drugs at the site of absorption. It is a part of controlled drug delivery system Drug delivery across the mucosa bypasses the first-pass hepatic metabolism. It will help in avoiding the degradation of drugs by gastrointestinal enzymes. It is the best choice for delivering a growing number of high-molecular-weight sensitive molecules such as peptides and oligonucleotides & poorly absorbed drugs. The advantages of MDDS include prolonged residence time of drugs at the site of application or absorption, the improved therapeutic performance of the drug, high drug loading capacity, and intimate contact of the dosage form with the underlying absorption.

Mechanism of Mucoadhesion

Mucoadhesion is defined as the adherence of mucoadhesive polymer to the mucosal layer held together by chemical or mechanical bonds. The mechanism of mucoadhesion involves two stages as follows:



1. Wetting and swelling- Contact stage
2. Interpenetration of the bioadhesive polymer
3. Formation of weak chemical bonds- Consolidation stage

Mucoadhesive polymer is an artificial substance that is capable of interacting with mucus membranes and being retained on them or holding them together for a prolonged period. Swelling should favor polymer chain flexibility & interpenetration between polymer & mucin chains. Examples of mucoadhesive polymers are polyacrylic acid (PAA), polyvinyl alcohol (PVA), and sodium alginate. Recently chitosan & its derivatives which are known for their MA properties are widely used in drug delivery systems. Along with mucoadhesive polymer, penetration enhancers, enzyme inhibitors are also used for drug delivery.

Role of Chitosan- A Mucoadhesive Polymer

Chitosan, a non-toxic N-deacetylated derivative of chitin, is a positively charged polymer. It has intensive progress towards the development of safe and efficient chitosan-based drug delivery systems. It is recognized as a versatile biomaterial due to its biodegradability, biocompatibility, and non-toxicity. Hence, they are employed to be used to improve the formulation of peptide drugs. As a result, it shows a very much enhanced cellular permeability and allows adequate therapeutic concentration of drugs into the systemic circulation. It also encapsulates drugs to protect them from degradation in the GIT environment. Nanoparticle systems to transport peptide drugs across the epithelial membrane are also developed.

Factors Influencing Chitosan Properties

Amino group in chitosan exhibits high solubility in acidic medium and able to form complexes with metal ions. These positive charges interact with drugs and physiological barriers in the GIT which is useful in drug delivery system. The Chitosan properties to be considered before using it as polymer includes:

1. Degree of deacetylation- Affects its biological activity like swelling rate.
2. Degree of substitution.
3. Molecular weight.

Most of the chitosan applications are affected by these factors through intermolecular or intramolecular hydrogen bonds

Modification of Chitosan as Biomaterial

The chitosan cannot be used directly. The effectiveness of using chitosan is lesser. Hence, it requires some modifications in order to enhance its activity. The modified chitosan (chemically or physically) shows greater advantages as compared to unmodified chitosan. Modifications are required to improve its solubility, properties of gelling, and biocompatibility. Common modifications are as follows:

1. **Quaternisation-** Quaternary ammonium salt + chitosan. E.g., Trimethyl chitosan
2. **Sulfonated chitosan-** Anticoagulant. Amphotericin B formulation
3. **Thiolated chitosan-** Thiolycolic acid + chitosan. Enhance adhesion & residence time. E.g., Trimethoprim delivery
4. **Carboxy alkyl chitosan-** deliver constant amount of drug per unit time. E.g., carboxymethyl chitosan

Oral Peptide and Protein Delivery

Peptides ate the smaller sequence of 20 to 50 amino acids such as vasopressin and oxytocin whereas proteins are macromolecules with heavyweight polypeptides made up of more than 50 amino acids. There are various barriers that prevent the delivery of protein and peptide vaccines and drugs. The barriers may reduce the bioavailability of these drugs. Common barriers are biochemical, cellular, and mucus barriers. The major challenges faced by protein and peptide drugs are due to:

1. Presence of proteolytic enzyme and pH of GIT.
2. Intestinal barrier to drug absorption- Epithelial layer with mucus.
3. Tight junctions between adjacent epithelial cells.

Strategies to Improve Oral Peptide Delivery System

The effective delivery of oral peptide drugs can be achieved by:

1. Altering the formulation for maximum solubility.
2. Avoid enzymatic degradation.
3. Enhance the absorption of drugs through the intestinal epithelial cell.

The enzymatic degradation or inactivation can be prevented by addition protease inhibitor or proteolytic enzyme. The improvement of membrane permeability can be achieved by the inclusion of a permeation enhancer (tight junction selective or membrane perturbing).

Role of Chitosan for Improvisation

Chitosan and its derivatives have been used as an enzyme inhibitor, permeation enhancer and mucoadhesive agent:

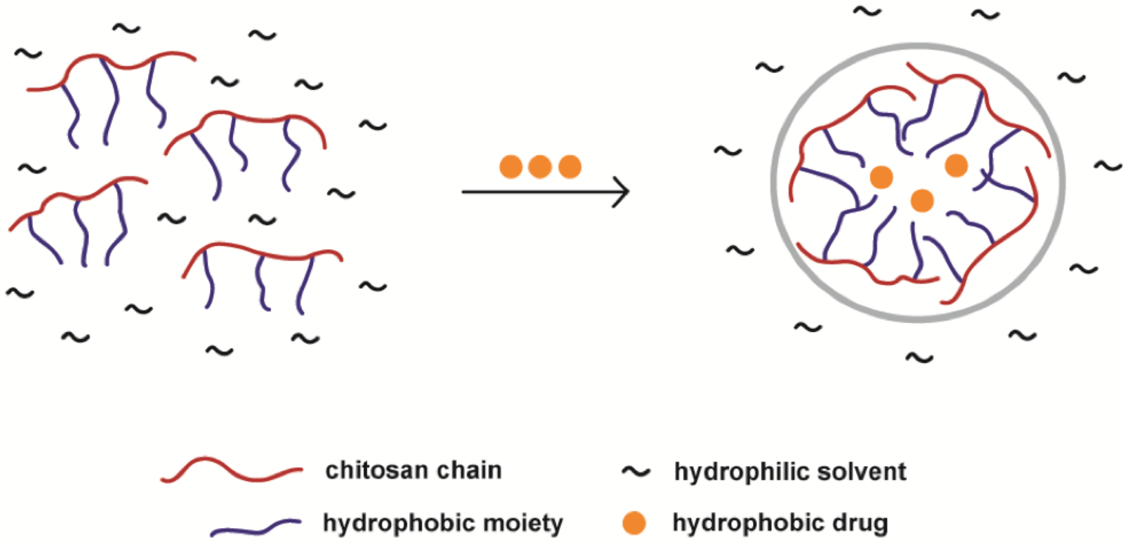
1. **Enzyme inhibition-** E.g., chymostatin linked with chitosan can enhance their anti-protease activity and minimise peptide drug degradation.

2. **Mucoadhesive agent-** Thiolated chitosan. Form sulphide bond with cysteine domains of mucus & allows greater mucoadhesion & good absorption of the peptide drug.

3. **Encapsulation** of peptide into the nanocarrier and chitosan as carrier/ polymer enhance drug delivery

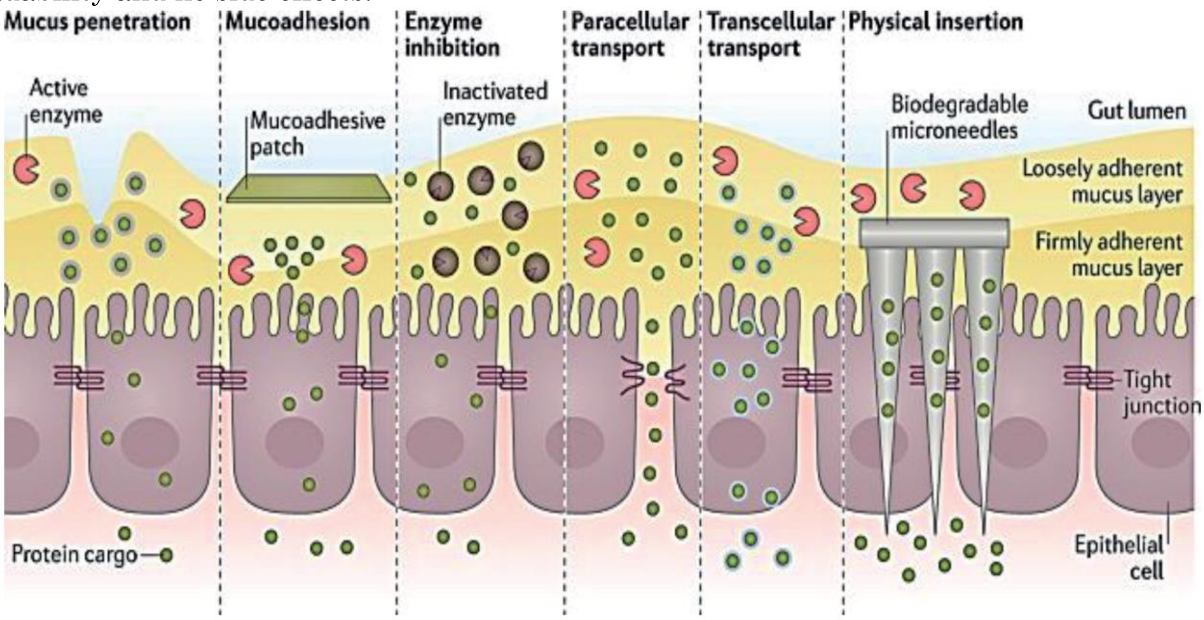
4. **Efflux pump inhibition chitosan** enhance paracellular permeability by modulating claudin protein.

Chitosan can act as a mucoadhesive patch retaining the drug for a longer period for absorption. It also inhibits the GIT enzymes. It aids in the transport of drugs into the cell by various mechanisms. Common mechanisms are paracellular transport, transcellular transport. Paracellular transport refers to the transfer of substances across an epithelium by passing through the intercellular space between the cells. It is in contrast to transcellular transport, where the substances travel through the cell, passing through both the apical membrane and basolateral membrane.



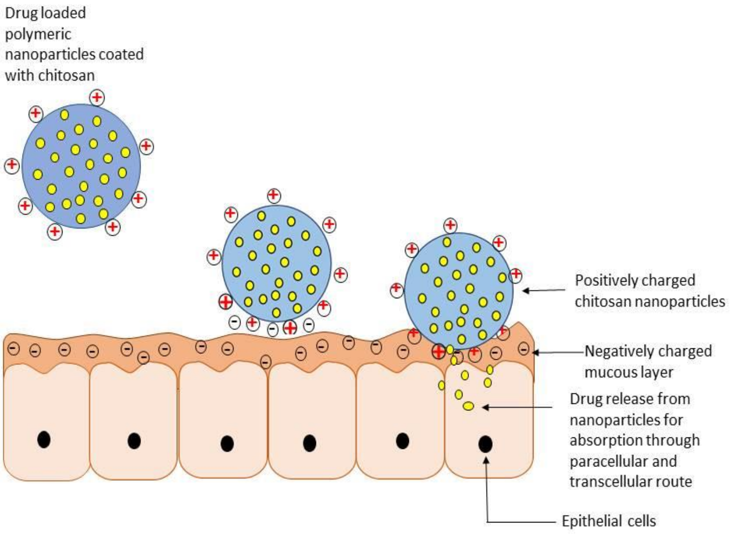
Microneedles are microscopic applicators used to deliver vaccines or other drugs across various barriers: while the transdermal application is the most popular use of microneedles, intraocular and intracochlear microneedle drug delivery systems are emerging. Microneedles are constructed through various methods usually involving photolithographic processes or micro molding. Some microneedles are made of a drug to be delivered to the body but are shaped into a needle so they will penetrate the skin. The microneedles range in size, shape, and function but are all used as an alternative to other delivery methods like the conventional hypodermic needle or other injection apparatus.

Microneedles are made from a variety of materials ranging from silicon, titanium, stainless steel, and polymers. Nowadays, chitosan is employed for using as microneedles to deliver drugs due to its biodegradability and no side effects.



Chitosan Coated Nanoparticle

Through the manipulation of size, surface characteristics and material used, the nanoparticles can be developed into smart systems, encasing therapeutic and imaging agents as well as bearing stealth property. Further, these systems can deliver drug to specific tissues and provide controlled release therapy. Chitosan can be explored to deliver the nanoparticle drugs due to its positive charge which can bind efficiently with negatively charged mucus.



Conclusion

Chitosan-based drug formulation has gained attention for their ability to serve as a carrier and an enhancer for oral delivery of peptides and vaccines. Oral delivery is the most convenient and preferred route of administration. It has limitations due to the presence of the proteolytic enzyme, pH of GIT and the intestinal barrier to drug absorption. In recent years, there has been considerable research interest in the application of chitosan as an enzyme inhibitor, mucoadhesive agent and efflux pump inhibitor. Interaction of positively-charged amino groups of chitosan with negatively-charged sialic acid groups that exist in mucin prolongs the residence time between drugs and membranes, therefore enhancing the bioavailability of the drugs. Other formulation strategies include encapsulation of proteins, peptides and vaccines into a nanoparticulate delivery system. By encapsulating peptide into a nanocarrier system, the enzymolysis and peptides aggregation can be avoided thus enhances the absorption of peptide drugs in the intestinal epithelium. Hence, there is a lot of scope regarding chitosan in drug delivery system.

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WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Role of Biofertilizers in Fruit Crops Production

Article ID: 12049

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Abstract

Biofertilizers are most successful tool of agriculture and are microbial preparations containing living cells of different microorganisms which have the ability to mobilize plant nutrients in soil from unusable to usable form through biological process. Such type of micro-organisms is used which have different functions to increase plant growth & reproduction rate. Thus, it is observed that, Bio-fertilizer are essential elements of Organic farming which have important role in the management of soil fertility and status. its beneficial effect on soil health and increase in production of crop and are friendly to the environment & play vital role in the production of the fruit crops. Application of Bio fertilizers in agricultural field could be substitute to inorganic/chemical fertilizers which have different harmful effects.

Keywords: Bio-fertilizers, Micro-organisms, Soil fertility, Inorganic fertilizers.

Introduction

Today's era we need to only organic source of fertilization to soil and for proper growth and development of plants because only such type sources can resist against the diseases and different stresses and also maintains long term soil productivity and ecological sustainability. Biofertilizer are very important in fruit crops production to improving soil fertility by fixing atmospheric nitrogen and these are environment friendly because they are playing a significant role in enhancing production, and productivity with superior quality of fruits. According to Subba Rao (1998), biofertilizers are otherwise called microbial inoculants, are the carrier-based preparation containing beneficial microorganisms designed to improve the soil fertility and help the plant growth by their increased number and biological activity in the rhizosphere. Biofertilizers are also important in the soil because they solubilize insoluble soil phosphate and enhance the plant growth substances. Continuously use of biofertilizers, help host plants to resist again the diseases and also withstand stress conditions which are depending on type of biofertilizer agents involved on it. Biofertilizers are able to fix atmospheric nitrogen in the range of 20- 200 kg/ha/year, solubilize P in the range of 30- 50 kg/ha/year; mobilize P"Zn, Fe, Mo to varying extent. Biofertilizer is a cost-effective renewable energy source and plays a crucial role in reducing the inorganic fertilizer application and at the same time increasing the crop yield besides maintaining soil fertility.

Types of Biofertilizers

Nitrogen fixing biofertilizers	• Azospirillum (This is Associative symbiotic) • Rhizobium, Anabaena azollae, Frankia (Symbiotic) • Azotobacter, Nostoc, Klebsiella, Clostridium, Anabaena, Beijerinkia (Free-living)
Phosphorus mobilizing bio-fertilizer (PMB)	• Rhizoctonia solani *(Orchid mycorrhiza)* • Amanita sp., Boletus sp., Pisolithus sp., Laccaria sp. (Ectomycorrhiza) • Scutellospora sp., Gigaspora sp., Glomus sp., Acaulospora sp. (Arbuscular mycorrhiza) • Pezizellaericae. *(Ericoid mycorrhizae)*

Phosphorus solubilizing bio-fertilizer (PSB)	• *Psuedomonas striata, Bacillus megaterium* var. *phosphaticum, B. circulans, B. subtilis* (Bacteria) • *Aspergillus awamori, Penicillium* sp. (Fungi)
Plant growth promoting bio-fertilizer (PGPB)	• *Psuedomonas fluorescens*
Bio-fertilizers for Micronutrients	• Silicate and *Zinc solubilizers* (Bacillus sp.)

Role of Biofertilizers in Fruit Crops

1. Effect on growth: Singh and Singh (2004), reported that VAM significantly increase growth of plants compared to non-mycorrhizal control and was also effective in increasing nutrient uptake by the plants. VAM influenced growth attributing character and yield attributing component. About 50% phosphorus can be achieved through the application of VAM and it increase the growth of plants. VAM also effective in papaya in increasing the plant height, stem girth, petiole length and number of leaves and on pomegranate mycorrhizal treatment were superior over non-mycorrhizal treatment in pomegranate. Inoculation with Glomus fascicu/atum and Azotobacter chrococcum produce larger plants which had a more leaf area. Application of nitrogen and in combination with Azotobacter increase the plant height, plant girth, number of hands! bunch and number of fingers in banana cv. Robusta

2. Effect on yield: Sharma (2002) in Assam revealed significant increase in the bunch weight and yield of banana with Azotobacter and organic manures supplements over 100% fertilizer. Azotobacter also enhanced shooting and shortened crop duration. Wang et al. in (1998) reported that there is increase in number of fruits per plant, total weight of fruits and average fruit weight in strawberry as compared to the control by the application of Azotobacter, Azo-spirillum and P-solubilizing bacteria. Dalal et al. (2004) reported that the yield of the sapota is greatly increased due to the application of 75 kg FYM + 1500 g N + 1000 g P + 500g K + 12.5 g PSB. Benefit cost ratio is also high as compared to other fertilizer combinations.

3. Effect on soil: Gogoi (2003) reported that the combined application of inorganic fertilizer and biofertilizers in banana cv. 'Barjahaji' significantly increased the available NPK status, organic C and microbial biomass and dehydrogenase activity in soil after harvest. Ruiz et al. (1992) from Cuba, observed that the quantities of beneficial microorganisms in the soil increased considerably due to the use of Azotobacter mycorrhiza and phosphorins in banana. The commercial yield is also increased by 25-30% and save 50% of inorganic fertilizers. In Banana, the plants of ev. Elakki Bale were studied for their response to inoculation with biofertilizer by (Mohandas, 1996) viz. VAM, phosphate solubilizing bacteria and AzospiriIlum brasilIense alone or in combination. VAM colonization was found upto 70-80% while that of PSB and Azospirillumwas found upto 70%. The available P in the soil increased in VAM and PSB treatments and available soil N increased in Azospirillum treatment.

4. Effect on quality: Singh et al. (2000) reported that the treatment combination of % P + VAM + N was the best treatment for producing better growth and yield of high-quality fruit in Mosambi. This treatment also influences plant height, trunk diameter, canopy volume, root growth and biomass production as compared to control. Suresh and Hasan (2001) in West Bengal evaluated the response of inoculation with Azospirillum and phosphobacteria on fruit quality of banana (Musa MA) cv. Giant Governor by manipulating the doses of nitrogen and potassic fertilizers. The results revealed that inoCillation of biofertilizers along with the application of recommended dose of fertilizer proved most effective in improving fruit quality of Dwarf Cavendish banana cv. Giant Governor. Rana and Chandal (1999) reported that the plant growth, yield and fruit quality of strawberry were significantly increased with the application of biofertilizer and nitrogenous fertilizers. Maximum TSS content was observed with Azotobacter inoculation along with 80 kg N/ha.

5. Influence to control different diseases & disorders in fruit crops: Chandra et al. (2014) Diseases Index of Papaya inoculated with the Pseudomonas straita [PSM] & Inorganic Fertilizers. The result revealed that the trends of Plant Disease Index (PDI) was decrease by [51.36%] with T1, PSM (T1) alone followed by T3 (27.89%), combination with N, P, & K (T3). Torshiz et al. (2017) Influence of biological fertilizers on sunburning and cracking of pomegranate & infestation to pomegranate fruits moth Ectomyelois Ceratoniae (Lepidoptera: Pyralidae). Results revealed that plant treated by a combination of humic have higher levels of macronutrients and micronutrients & biofertilizer related with untreated plants, Completly, that biological fertilizers when combine with organic fertilizers, like granular humic, are advantageous to pomegranate plants orchard for the management and prevent from crop losses due to cracking, nutrient deficiency and infestation of E. Zhang ZhiHong et al. (2010) Effect of Bio-fertilizers to control the banana wilt disease. Results revealed that 3 kinds of fertilizers had disparate effect on the biological control of banana wilt disease significantly. The Disease index of BOF & BCF treatment was lower than that from the single Foc. Thus, Control effect of BOF & BCF on banana wilt disease were 53.9% & 61.4%. Related to BOF & BCF with OF. It was observed that bacteria which are functional played significantly role in the disease inhibition. Zongzhuan et al. (2015) Influence of combination of amyloliquefaciens Bacillus NJN-6 and biological fertilizers to control Fusarium wilt disease of Banana. Result shows that actinobacteria, culturable bacteria & Bacillus populations, Bacteria which is culturable to fungi (B/F) control the fusarium wilt disease of Banana.

Conclusion

Bio-fertilizers are beneficial for the growth, yield, quality, control of different diseases and also maintain the fertility and status of the soil as compared to chemical fertilizers of different fruit crops because chemical fertilizers are the very toxic substances to soil, plants and our food chain and they deteriorate the quality. By the application of organic & biological fertilizers we can increase the fertility of soil, water holding capacity of soil, healthy, productive and nutritional food with quality. We should promote the biofertilizers application to Indian farmers instead of application of chemical fertilizers.

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Insect Growth Regulators (IGRs) as Third-Generation Pesticide

Article ID: 12051

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A pest is a creature that is detrimental to human or their wellbeing including the cultivation of crops, rearing and domestication of animals. Among these creatures, insect pests cause massive destruction in a variety of crops. To tackle such menace there are various tools like cultural operations, mechanical means, chemical control and biological control. There are chemicals for the management of insect pests like Thiomethoxzome and Imidaclorprid used to manage insect pests of soybean crop (Upadhyay *et al* 2017). Conversely, the development of resistance against insecticides, pest resurgence, secondary pest outbreak and heave disquiet about the environmental impacts of agricultural inputs give urgency to screening and investigation for an alternative. We should opt for rational use of chemicals only when required, one such category is insect growth regulators.

Insect Growth Regulators (IGRs) are compounds that meddle with the growth, development and metamorphosis of insects by affecting the insect endocrine systems. IGRs include synthetic analogues of insect hormones such as ecdysoids and juvenoids and non-hormonal compounds such as precocenes *i.e.* anti-juvenile hormone and chitin synthesis inhibitors. Synthetic compounds possessing activities of juvenile hormone and moulting hormone of insects are often termed as 'mimics' or insect growth regulators.

There are hormones in insects that perform a part in development and growth few examples are as follows:

1. Brain hormone - Often called activation hormone. It is secreted by neurosecretory cells which are neurons of the central nervous system. Its task is to activate the corpora allata which are paired glands present behind the insect brain to produce a juvenile hormone (JH). It is secreted by corpora allata.

2. Ecdysone - Also termed as Moulting hormone. Ecdysone is a steroid and is secreted by prothoracic glands present near prothoracic spiracles. Moulting in insects is brought about only in the existence of ecdysone. Ecdysone level decreases and is altogether absent in adult insects.

3. Juvenile hormone - Additionally referred to as neotinin. Corpora allata secret it to keep the larva in juvenile condition. There are JH I, JH II, JH III and JH IV have been identified in various insects' groups. The concentration of JH decreases as the larva grows and reaches the pupal stage. JH I, II and IV are found in larva while JH III is found in adult insects and are important for development of the ovary in adult females.

In Integrated Pest Management the Use of Insect Growth Regulators

1. Chitin Synthesis inhibitors - Benzoyl phenyl ureas have been found to have the ability to inhibit chitin synthesis in vivo by blocking the activity of the enzyme chitin synthetase. Two imperative compounds in this category are Diflubenzuron (Dimilin) and Penfluron. The compounds belonging to the chitin synthesis inhibitors class were found effective against orders like Hemiptera, Lepidoptera, Coleoptera, Orthoptera, Thysanoptera and Diptera. The foremost kind of actions come together were morphological and anatomical modifications, reproductive modifications, alterations in the developmental stage, alterations in developmental period, ovicidal activity, larvicidal activity (Apolinário and Feder, 2021).

2. Ecdysoids - The synthetic analogues of natural ecdysone are known as ecdysoids. Whenever applied on insect pests it leads to the establishment of substandard cuticle formation, also deficient in a waxy layer, scales and extracellular growth.

3. Juvenoids - These are artificial analogues of juvenile hormone. Juvenoids have anti-metamorphic effect on immature stages of insects, these are one of the effective hormonal insecticides. These compounds restrain the process of embryogenesis, impart ovicidal, larvicidal and interrupt diapause. The juvenoids are responsible for the steady development of growing stages like larva remains in the larval stage and continued moultings leads to super larva, larval-pupal and pupal-adult intermediates which cause the death of insects. This compound possesses low mammalian toxicity and environmentally compatible.

4. Precocenes - These are also called anti juvenile hormone and act by destroying corpora allata and preventing JH synthesis. When treated on immature stages of insects, they skip one or two larval instars and turn into tiny precocious adults. They can neither mate, nor oviposit and break down shortly. Eg. EMD, FMev, and PB (Piperonyl Butoxide).

Juvenile Hormone Analogues, these Compounds are Comparable to Each Other, which Interfere with the Growth and Development of Insects as Follows

1. Buprofezin - They are responsible to obstruct moulting and are found effective against hemipteran pests like brown plant hopper. Buprofezin is obtainable with the name of Applaud.

2. Diflubenzuron - It is accessible in the market with the trade name of Dimilin, hinder the chitin synthesis further disturbs the moulting. It is effective against coleopteran and lepidopteran insect pests.

3. Knioprene - It hampers the chitin synthesis and moulting, efficient against whiteflies and mealybugs. The kinoprene example is Enstar.

4. Lufenuron - It is found effective against diamondback moth and gram pod borer available as Match 5 EC or ' Rimon' 10 EC.

5. Methoprene - It is a mimic of juvenile hormone works as JH analogue, effective against many dipterans like horn fly larvae, mosquito larvae, homopterans, leaf-mining flies of green house plants, red ants, etc. It is available with the trade name Altosid.

Abbas and Hafez (2021) have studied on some commercial-grade formulated IGR groups including pyriproxyfen (Admiral 10EC, Sumitomo Chemicals, Japan), diflubenzuron (Diflon 250WP, Saudi Delta Company, SA), triflumuron (Starycide 480SC, Bayer Crop Sciences, Germany), cyromazine (Novasat 75WP, Astranova Chemicals, SA), and methoxyfenozide (Runner 24SC, Dow Agro-sciences, UK) and recorded their efficacy against dipteran pest.

Insect Growth Regulators from Neem

Neem (*Azadirachta indica* A. Juss., Family: Meliaceae) is an evergreen tree native to the Indian subcontinent. The Leaves and seed extracts of neem which contains azadirachtin as the active ingredient, when applied topically causes growth inhibition, malformation, mortality and reduced fecundity in insects.

Insect Growth Regulators Mimics Obtained from Other Organisms

Phytoecdysoids have been reported from plants of mulberry, ferns and conifers. Juvenoids have been documented from various plants, yeast, fungi, bacteria, protozoans and higher animals.

Advantages

1. Target explicit thus safe and sound to natural enemies and beneficial insects.
2. It is found to be efficient in minuscule quantities also hence economical to use.
3. IGR are non-persistent, non-polluting and bio-degradable consequently eco-friendly.
4. Non-toxic to humans, animals and plants.

Disadvantages

1. Insect growth regulators possess a slow mode of action.
2. They exterminate only certain stages of the pest.
3. These compounds are unstable in the environment.
4. There is always a likelihood of resistance build-up for the reason that IGRs are mere chemicals.

Conclusion

The Adequacy and execution of control measures against insect pests depend on the host plant and pest behaviour irrespective of the environment. The rapid growth of pests in the crops of greenhouse amenities may augment insecticidal usage, which ultimately may lead to resistance problems in the future. Therefore, the management of crop pests should be specific, resilient and use of insect growth regulators must be on the judicious basis merely. Moreover, the integration of insect growth regulators with cultural practices and other tools of integrated pest management may suppress the resistance problem.

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Applications of Remote Sensing in Fisheries

Article ID: 12052

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Remote Sensing

Remote sensing is a branch of science having information about objects from measurements made from a distance, deals with the use of light, i.e., electromagnetic radiation as the medium of interaction. Each object reflects an electromagnetic radiation incident depends on physical properties, and also objects emit electromagnetic radiation depending upon their temperature & emissivity. The reflectance pattern at different wavelengths for each object is different, known as the object's spectral signature. There are various stages in remote sensing such as the requirement of an energy source, energy interaction with the atmosphere, interaction with the target, recording of energy by the sensor, data transmission & processing, image processing & analysis and application

A fisher must catch the most fish possible while minimizing costs and operation time to exploit marine resources more effectively. Remote observations of the marine provide information about the fishing ground, school of fish that helps to improve the fish catch. In earlier days, remote sensing was predominantly used to assist in efficient harvesting. In recent years, they used for resource management, conservation and exploitation. The environmental conditions affect the distribution, recruitment, availability and abundance of fishery resources. It is not possible to measure the entire marine environment. Knowledge of particular conditions and processes that affect the fish populations may often be deduced using parameters such as concentration of dissolved and suspended matter, primary production, location of frontal boundaries, distribution of surface isotherms, and upwelling region currents and water circulation patterns made by remote sensors. These parameters are providing information on the environmental condition, which helps to forecast fish distribution. These are often easier to identify the available fish quickly. The remote sensing techniques can be utilized directly, indirectly, or as general aids in detecting and assessing fishery resources.

Direct Method

Visual fish spotting is the direct and simple method of remote sensing in fisheries. Fishing fleets exploit major fisheries such as tuna and menhaden depending on visual fish spotting from aircraft to direct their fleets. The aerial photography provides information about pelagic fish's distribution and relative abundance, particularly the schooling species. Echo-sounders and sonars are used as remote sensors for at least 50 years and are now widely used by the world's fishing fleets. Sonars are used for the detection of fish and biomass estimation. In recent years, high powered laser systems used in the blue-green portion of the visible spectrum (lidar) have shown promise for evaluating fishery resources.

Indirect Methods

The estimation of a fishery resource by measuring parameters that affect the distribution and abundance of resources. The environmental parameters most commonly measured from airborne and spaceborne sensors are as follows: surface temperature, bio-optical or surface optical properties, vertical and horizontal circulation features, salinity, oil pollution and sea state.

Surface Optical Properties

The optical properties are determined by the presence of dissolved and suspended matter. In normal conditions, the visible light penetrates up to ten meters in marine waters, but the dissolved and suspended matter concentration increases the light penetration is reduced. The absorption and scattering processes vary with the wavelength of the incident radiation, which depends on the specific characteristics of the materials. Multispectral observations are used to estimate the nature and concentration of the water constituents. Passive sensors such as CZCS, MSS, TM, HRV, which work in the visible wavelengths, are commonly used to capture water colour images. Active sensors are providing their source of illumination.

Diffuse Attenuation Coefficient

At a given wavelength, the diffuse attenuation coefficient is an apparent optical characteristic. The light dispersion determines its size at the measurement site, which is affected by spreading, scattering, and absorption.

Yellow Substance

The yellow substance is a crucial parameter to monitor in polluted coastal waters because it may be used to identify marine areas were filter feeders, such as shellfish, may be at risk.

Chlorophyll Pigments

The concentration of chlorophyll pigments is often considered an index of biological productivity and, in an oceanic environment, can be related to fish production. Chlorophyll concentrations above 0.2 mg/cu.m indicate the presence of sufficient planktonic life to sustain a viable commercial fishery.

Surface Temperature

The National Oceanic and Atmospheric Administration in the US (NOAA) has engaged in sea surface temperature (SST) determination from satellite-derived data since 1973. The SST is data in contour maps or computer printouts with smooth and radiometrically corrected measurements. The TIROS, NOAA and the METEOSAT satellites produced the SST charts (accuracy of 0.5°–2°C) and near real-time.

The NOAA series of heliosynchronous satellites give high resolution (1 km) images twice daily, but the geostationary satellites (GOES, METEOSAT) provide images every 1/2 hour but only a 5 km resolution. SST maps are currently utilized mainly by salmon and tuna fishing fleets. Some tuna species graze on the warm seaward side of thermal fronts, while salmon feed on the chilly landward side, as is well known. SST has also been linked to the occurrence of other species. Physical features relevant to fisheries, including gyres, eddies, inversions, and upwelling, can also be spotted using SST maps.

Circulation Features

Several remote sensing techniques can offer surface circulation characteristics that are important in determining marine fish habitats. These factors include frontal boundary location and evolution, upwelling zones, currents, and circulation patterns in general. Surface water optical and thermal properties can be exploited as natural tracers of dynamic patterns.

As a result, the preceding topic of sea surface colour and temperature should be revisited in light of this application. Microwave technology, especially active sensors (radar altimeter), can study large-scale circulation patterns. Remote observations of water surface vertical displacements, for example, can reveal information about a basin's dynamic properties.

Salinity

At this time, the salinity measurement by remotely sensed data is not used. The emissive brightness temperature can be used to measure the salinity of sea water from a distance. This technique's precision may be sufficient for tracking the spread of fresh water at a river mouth, as well as investigating estuaries and near-shore waters.

Oil Pollution

Visual detection by eye, aerial camera, MSS, and CZCS; fluorescence detection by lidar; microwave detection by SMMR and SAR; and thermal detection by IR scanner are among the many technologies utilized for oil detection at the sea surface. The visual technique depicts the colour and brightness changes caused by the presence of oil.

Sea State

The distribution of fish is affected by the rough sea conditions caused by the wind. In near-real-time, SAR-equipped aircraft or satellites can survey the sea state of fishing grounds. A ground control station can convey this information to a fisherman.

Advantages of Remote Sensing

The advantages of remote sensing over ground-based methods are synoptic view, accessibility, time and multidisciplinary applications.

Synoptic view: It allows for examining numerous earth surface features in connection to one another and aids in delineating required features and phenomena.

Accessibility

It allows for the collection of data in inaccessible places where ground surveys are impractical.

Time

These techniques save time & effort as information about large area can be gathered quickly.

Multidisciplinary Applications

Remote sensing data are helpful in different disciplines such as geology, fisheries, forestry, land use etc.

AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Promotion of Non-Timber Forest Products (NTFPs) as a Tool for Rural Economic Development

Article ID: 12053

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Introduction

Forests are essential to the world's ecology, social, cultural, and economic well-being. Forest resources and products, both wood and non-wood, are important for the survival of a large portion of the world's population. (FAO, 1999). NTFP / NWFP are defined as *"Goods of biological origin other than wood, derived from forest, other wood land, and trees outside forests"*. For food, medicine, and fibre, over 2 billion people around the world rely on non-wood and wood forest resources for food and income (FAO, 1999). India is among the world's 12 mega-biodiversity countries, contributing 8% of global biodiversity despite having only 2.4% of the total land area (Reddy, 2008; Hajra and Mudgal, 1997). NTFPs provide primary health care and food security to about 80% of the world's population in developing countries.

NTFPs' Contribution to Rural Livelihood

India is a land with a wide range of forest resources and is entirely reliant on agriculture. NTFPs provide 40% of forest revenue and 55% of forest employment in India. It is projected that 275 million poor rural people, or 27% of the population, rely on NTFPs for at least part of their sustenance and livelihood opportunities (Malhotra & Bhattacharya, 2010; Bhattacharya & Hayat, 2009). Near 3000 NWFPs species produce NTFPs, but still only 126 have commercial potential (Maithani, 1994; FAO, 2002; FAO, 2005). India's forests provide the farmers and forest-dwelling communities with all of the materials they require. Edible plants, such as leaves, fruits, seeds, roots, and other parts continue to play a significant role in the poor's diet, particularly among those who live near forests. Madhya Pradesh, Jharkhand, Gujarat, Chhattisgarh, Maharashtra, Rajasthan, Orissa, and the North Eastern States account for roughly 70% of the total tribal population (Tewari, 1993). The tribal peoples of all of these states are largely reliant on various forest resources for survival. And around 50 million forest dwellers, the majority of whom are tribal, rely on forest resources for survival. However, NTFP is also used by 200 to 300 million non-tribals to a lesser extent (Shiva, 1993; World Bank, 2006).

The Classification of NTFPs

Plant products:

a. Food: Edible plants part such as fruits, nuts, seeds, and bamboo shoots which provides leafy vegetal foods and beverages.
b. Fodder: leaves, fruits etc.
c. Medicine/Aromatic: Spices and medicinal plants (e.g., leaves, bark, roots).
d. Colorants/dyes: Colorants derived from plant material (mostly bark, leaves, and fruits).
e. Utensils/crafts/building materials: thatch, bamboo, rattan, wrapping leaves, fibres (Floss, Silk cotton floss)
f. Ornamental plants: Entire plants parts, parts of the plants which are used for ornamental purposes.
g. Exudates: Substances such as gums (water soluble), resins (water insoluble) and latex (milky or clear juice released from plants by exudation
h. Other plants products: Tendu leaves and lac etc.

Animal products:

a. Living animals: Birds, reptiles etc.
b. Hides, feathers, skins and trophies
c. Honey and beeswax

d. Bushmeats: Meat provided by vertebrates, mammals.
e. Medicine: Entire animals or parts of animals such as various organs used for medicinal purposes (e.g., caterpillars, crab legs, snake oil).
f. Colourants: Entire animals or parts of animals such as various organs used as colorants.
g. Other non-edible animal products, e.g., bones used as tools.

Significance of Wild Foods to the Rural Communities

Figure: Forest food products and nutrition security are linked to forest resource management and better health. (Source: Clindon 2001).

Potential of Non-Timber Forest Products Markets

The economic benefit of NTFPs depends on the region, depending on customs/consumption patterns (demand structure), forest types, and availability (supply structure). The value of NTFPs is essential as a source of income and employment for rural people living near forest areas, particularly during agricultural crop lean seasons. Many tribal communities rely entirely on NTFPs to meet their nutritional and economic needs. The rural community utilizes the forest to collect medicinal plants, edible plants, starches, gums, and mucilages, oils & fats, resins & oleo-resins, essential oils, spices, drugs, tannins, insecticides, natural dyes, bamboos & canes, fibres & flosses, grasses, tendu leaves, animal products, and edible products in quantity that are economically significant and also serve as traditional ingredients in their cuisine. In the plains, tendu leaves, Sal seeds, and Mahua flowers provide the majority of employment, while in the Himalayan region, resin and medicinal plants play a similar role. Tendu-leaf collection and beedi-rolling industries generate employment of over 3 million people.

Traditional Methods of NTFPs Marketing

1. Barter system.
2. Sale to local traders.
3. Sale in the village market.
4. Sale in the weekly market.
5. Sale at railway stations/ highways.
6. Sale at tourist places.

Market Channels for NTFPs

NTFPs are marketed through different channels depending upon a variety of factors such as nature of the product, demand and distance of the market.
Collector → Tribal agent → Primary wholesaler/Retailer → Consumer
Collector → Tribal agent → Secondary wholesaler/ Commission agent
Collector → Primary wholesaler/Retailer → Consumer
Collector →Primary wholesaler/ retailer → Secondary wholesaler/Commission agent
Collector → Secondary wholesaler/Commission agent

Recommendation and Conclusion

1. Strengthened Cooperative marketing societies at the village level.
2. A governing body for NTFPs should be established, similar to the APMC (Agricultural Produce Market Committee), to set a minimum support price for non-nationalized NTFPs and to keep a close eye on NTFPs cash flow.
3. VFPC (Village Forest Protection Committee)/ Self Help Group with user industries/trading bodies for direct selling their value-added products will enable tribals to get a good return on their products by connecting them to actors further along the value chains.
4. Provide producers with training in value-added activities and update them about current market information, market value awareness and resources from time to time.
5. Establishing an NTFPs coordinating body and an NTFPs marketing and information network;
6. Support from Government or non-governmental organizations (NGOs) in the form of various schemes, incentives that can aid in the establishment of micro enterprises that meet local needs.
7. Promoting and enhancing NTFPs and extension.

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Hidden Treasures of Neglected and Underutilized Crop Species

Article ID: 12054

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Nature's bounty' is a term that needs no definition. It is what feeds us, clothes us, warms us, shelters us, defines our livelihoods and underlies the myriad cultures of human populations. All of this bounty rests on plant life, upon which all animal life, including that of humans, ultimately depends. Approximately 30,000 edible plant species have been identified, of which more than 7,000 plant species have been used in the history of humanity to meet food needs (FAO 1998). At present, however, no more than 150 species are commercially cultivated and, of these, just 103 crops provide up to 90% of the calories in the human diet. just four of these (rice, wheat, maize and potato) account for fully 60% of the human energy supply.

Almost all the efforts of the Green Revolution from the 1960s through the 1980s focused on improving these major staple crops. However, from the perspective of sustainable food security, relying on such a narrow food base makes our food supply extremely vulnerable. Basing our diet on a very small number of major crops has dire implications for both food security and nutrition.

The lack of genetic diversity within the genepools of these few crops leaves our agricultural systems vulnerable to pests and diseases, and to abiotic stress. In this inter-connected world, a variation on the devastating Irish potato famine of the nineteenth century could have far-reaching and disastrous consequences.

Foretastes of what could happen were experienced in the 1970s, when hybrid varieties of maize were shown to be sensitive to leaf blight, in 1930 when a fungus damaged all taro cultivation in Samoa, and in 1875 when a rust fungus devastated the coffee crop in Sri Lanka. A current global threat to wheat production is stem rust. This aggressive and very destructive disease first appeared in Uganda, but has spread through the Middle East, destroying wheat crops. It is threatening wheat-producing countries worldwide where resistant varieties are lacking.

To prevent this and other food crop calamities, there is clearly a need to maintain diversity both within and between crops in our production systems. As a consequence of the commercial advantages of mono cropping and the high yield of many improved hybrid crops, crop diversity – typified by local, traditional crop varieties and minor crops – is being neglected by agronomists as well as extension services. In many areas these crops are being lost altogether, along with a wealth of traditional knowledge about their cultivation and uses.

At the same time, pervasive malnutrition, widespread poverty, degradation of agro ecosystems and the impacts of climate change on agricultural production call urgently for new efforts on neglected and minor crops, similar to those already being made in support of the primary food crops. It is becoming increasingly clear that bolder and more consistent action is needed to broaden the food basket of the world by supporting the development of traditional crops marginalized by current research and agricultural policies. Internationally, there is rising interest in new foods and other products that can contribute in novel ways to human health and nutrition.

This interest can be exploited to develop markets for non-staple crops from which poor communities can benefit, providing incentives for farmers to plant these crops. Agriculture must go beyond the Green Revolution technologies of the last half century, which were based on genetic improvement and increased yields of the staple crops, but at high external cost. While these increases did allow countries to reduce hunger, they also resulted in inappropriate and excessive use of agrochemicals, wasteful use of water in inappropriate irrigation schemes, loss of beneficial biodiversity (pollinators, soil fauna, etc.), water and soil pollution, and significantly reduced crop and varietal diversity.

What are NUS? Why are they Important?

Also known by various names such as lost, minor, traditional, alternative, orphan, underused, forgotten, indigenous, life support, crop for future, abandoned, niche, underdeveloped, vanishing, potential, subsistence, local, poor people's food, lesser-known species.

These are the plant species that have been used for centuries or more for their food, fiber, fodder, oil or medicinal properties, but have been reduced in importance over time due to a variety of agronomic, breeding, economic and cultural reasons. Farmers and consumers are using these crops less because they are in some way not competitive with other species in the same agricultural environment.

They are non-commodity crops and belong to a large, biodiverse group of thousands of domesticated, semi-domesticated or wild species. They may be locally adapted minor crops as well as non-timber forest species. The designation 'NUS' is also fluid, as when a crop is simultaneously a well-established major crop in one country and a neglected minor crop in another. In some countries, moreover, agricultural statistics and research do not distinguish between NUS and other crops.

NUS differ from staple crops in fundamental ways. They tend to be managed with traditional systems, use informal seed sources and involve a strong gender element. Their processing can be laborious, grading and packaging primitive and the products marketed locally with limited involvement of large enterprises.

Having long been neglected by mainstream agriculture for a variety of agronomic, genetic, economic, social and cultural reasons, today these crops are receiving increasing recognition because of their potential role in mitigating risk in agricultural production systems. Over the last ten years or so, an increasing number of projects have directed their attention to the significance of NUS in improving nutrition, generating income, maintaining ecosystem health and empowering the poor and marginalized, as well as in promoting cultural diversity.

Underutilized species is commonly applied to refer to species whose potential has not been fully realized. The term itself does not provide any information as to geographical (underutilized where?), social (underutilized by whom?) and economic (underutilized to what degree?) implications for example regarding the socio-economic implication of the term, many species represent an important component of the daily diet of millions of peoples in different parts of the world but their poor marketing conditions make them largely underutilized in economic terms.

Examples of NUS Used for Food from Around the World

Roots and tubers: Yams (*Dioscorea spp.*), taro (*Colocasia esculenta*),yacon (*Smallanthus sonchifolius*), ulluco (*Ullucus tuberosus*), arracacha (*Arracacia xanthorriza*), American yam bean (*Pachyrhizus spp.*), maca (*Lepidium meyenii*), oca (*Oxalis tuberosa*), parsnip (*Pastinaca sativa*), cocoyam (Xanthosoma sagittifolium) etc.

Cereals and pseudo-cereals: Einkorn (*Triticum monococcum*), emmer (*T. dicoccon*), spelt (*T. spelta*), tef (*Eragrostis tef*), fonio (*Digitaria exilis*), cañihua (*Chenopodium pallidicaule*), finger millet (*Eleusine coracana*), kodo millet (*Paspalum scrobiculatum*), foxtail millet (*Setaria italica*), little millet (*Panicum sumatrense*), proso millet (*Panicum miliaceum*), amaranth (*Amaranthus spp.*), buckwheat (*Fagopyrum spp.*), Job's tears (*Coix lacryma-jobi*)

Fruits and nuts: Maya nut *(Brosimum alicastrum*), breadfruit (*Artocarpus altilis*), baobab (*Adansonia digitata*), jujube (*Ziziphus mauritiana*), cherimoya (*Annona cherimola*), cape gooseberry (*Pysalis peruviana*), naranjilla (*Solanum quitoense*), noni (*Morinda citrifolia*), marula (*Sclerocarya birrea*), tamarind (*Tamarindus indica*), Annona (*Annona spp.*), safou (*Dacryodes edulis*), mangosteen (*Garcinia mangostana*), monkey orange (*Strychnos cocculoides*), salak (*Salacca spp.*), nipa palm (*Nypa fruticans*), duku (*Lansium domesticum*), boscia (*Boscia spp.*), carissa (*Carissa edulis*), coccinia (*Coccinia trilobata*), acacia (*Acacia toritilis*), kei apple (*Dovyalis caffra*), tree grapes (*Lamnea spp.*), medlars (*Vanguera spp.*), pitanga (*Eugenia uniflora*), Malabar chestnut (*Pachira aquatica*), camu camu (*Myrciaria dubia*), dragon fruit (*Hylocereus spp.*), Brazil nut (*Bertholletia excels*), egg nut (*Couepia longipendula*), quince (*Cydonia oblonga*), Yara Yara (*Duguetia lepidota*), Araza (*Eugenia stipitata*), lúcuma (*Lucuma obovata*), miracle fruit (*Synsepalum dulcificum*) etc.

Vegetables: Moringa (*Moringa oleifera*), African eggplant (*Solanum aethiopicum*), leaf amaranth (*Amaranthus spp*.), locust bean (*Parkia biglobosa*), winged bean (*Psophocarpus tetragonolobus*), chayote (*Sechium edule*), angle gourd (*Luffa acutangula*), snake gourd (*Thrichosantes cucumerina var. anguina*), Ceylon spinach (*Basella rubra*), spider plant (*Cleome gynandra*), black nightshade (*Solanum nigrum*), ivy gourd (*Coccinia grandis*), celosia (*Celosia argentea*), dika (*Irvingia spp*.), egusi (*Citrullus lanatus*), marama (*Tylosema esculentum*), shea butter (*Vitellaria paradoxa*), giant swamp taro (*Cyrtosperma merkusii*), akoub (*Gundelia tournefortii*), crambe (*Crambe spp*.), cardoon (*Cynara cardunculus*), eru (*Gnetum africanum*), purslane (*Portulaca oleracea*), golden thistle (Scolymus hispanicus), bitter leaf (*Vernonia amygdalina*) kankoda (*Momordica dioica*) etc.

Legumes: Mothbean (Vigna aconitifolia) adzuki bean (*V. angularis*), ricebean (*V. umbellata*), lupin (*Lupinus mutabilis*), Bambara groundnut (*Vigna subterranea*), jack bean (*Canavalia ensiformis*), grasspea (*Lathyrus sativus*), lablab (*Lablab purpureus*), African yam bean (*Sphenostylis stenocarpa*), Kersting's groundnut (*Macrotyloma geocarpum*).

Spice, condiment, food dye agent: Makoni (*Fadogia ancylantha*), annatto (*Bixa orellana*), pandan (*Pandanus amaryllifolius*), polygonum (*Poligonum odoratum*), antidesma (*Antidesma venosum*), uer (*Lippia carviodora*), rocket (*Diplotaxis spp*.), caper (*Capparis spinosa*), monkey cola (*Cola lateritia*), sea buckthorn (*Hippophae rhamnoides*), nigella (Nigella sativa) etc.

What Needs to be Done?

Raising the profile of NUS means:
1. Developing better varieties.
2. Improving cultivation practices.
3. Enhancing value adding technologies.
4. Helping producers get better access to markets.
5. Providing evidence and promoting the nutritional benefits of NUS.
6. More effectively maintaining on-farm genetic diversity.
7. Building the capacity of stakeholders.
8. Developing national and international policies to support sustainable conservation and use.

Conclusion

NUS are not intended to replace the major existing crops under different cropping farming systems. There is an urgent need to broaden the food basket of the world by supporting the development of traditional crops neglected and marginalized by current research and agricultural policies NUS, with their greater adaptability to extreme climatic conditions and their resilience to biotic and abiotic stresses, can be effective instruments for curbing food insecurity. Although they are characterized by lower yields, NUS will also produce harvestable yields where major crops may fail. They are also valuable in fighting hidden hunger and are particularly useful in improving diets that are too rich in refined carbohydrates and fats. In addition, agricultural production focused on agrobiodiversity can contribute to harnessing and safeguarding centuries-old traditions and is a powerful instrument for keeping alive the cultural identity of farmers and indigenous communities. Neglected and underutilized crops have great untapped potential to support smallholder farmers and rural communities by improving their incomes and food and nutritional security while also sustaining the genetic resources needed to address present and future environmental challenges. Making full use of these crops, however, will involve making them more commercially competitive with improved 'modern' varieties. Part of this poor competitive value is because poor rural areas often have little capacity to negotiate with the private sector, thus excluding the possibility of access to new technologies and markets that could increase the potential of these locally used crops.

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Historical Development of Mushroom Cultivation

Article ID: 12055

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The Prehistoric humans probably used mushrooms collected from the wild as food and possibly for medicinal purposes. Mushroom cultivation did not come into existence until 600AD when *Auricularia auricula* (wood ear or black ear mushroom) was first cultivated in China on wood logs.

Fig.1 *Auricularia auricula*

1. Other mushrooms, such as *Flammulina velutipes* (800 AD) and *Lentinula edodes* (1000 AD) were grown in a similar manner.
2. The biggest advance in mushroom cultivation came in France in 1630 when *Agaricus bisporus* was cultivated on a composted substrate.

Fig. 2 Flammulina velutipes

Fig. 3 Lentinula edodes

Fig. 4 Agaricus bisporus

3. The first method of mushroom cultivation and use of casing soil described by Tournefort in 1707.
4. In India the possibilities for establishment of mushroom cultivation were visualized by S R Bose in 1921with knowledge of cultivation of two agaricus on sterilized dung medium.
5. The paddy straw mushroom (*Volvariellavolvacea*) was first cultivated by Thomas *et al.* in 1943 in Madras (Chennai), while oyster mushroom (*Pleurotus* sp.) was first cultivated by Bano*et al.* in 1962 using paddy straw.

	
Fig. 5 Volvariella volvacea	**Fig. 6 Pleurotus sp**

6. The button mushroom (*Agaricusbisporus*) cultivation started systematically in 1961 with a launch of a scheme on “Development of mushroom cultivation in H.P.” by ICAR.
7. In 1965 Mr E F K Mantel (FAO mushroom expert) guided and assisted Deptt. of Agriculture H.P. for construction of modern spawn lab and fully airconditioned mushroom houses.
8. An ICAR sponsored co-ordinated project on mushroom research was started in 1971 with sub centres namely Solan (HP), Ludhiana (PB), Bangalore (KA) and New Delhi.
9. Mr. W A Hayes (FAO mushroom expert) in the year 1974 guided in improving the method of compost preparation, pasteurization and management of important parameters in mushroom houses.
10. In the year 1977 a mushroom development project was launched by Deptt. of Agriculture (HP) with the financial support (1.27 crore) from UNDP, where services of Mr. James Tunney (mushroom expert) were made available and bulk pasteurization chambers got constructed.
11. National Centre for Mushroom Research and Training (NCMRT) was sanctioned by ICAR in 1982 with its head quarter at Solan (HP).
12. In 1983 ICAR sanctioned the All-India Co-ordinated Mushroom Improvement Project with its H.Q. at Solan along with six sub centres i.e., Pantnagar, Ludhiana, Coimbatore, Pune, Kanpur and Kalyani.
13. In 1997 NCMRT was renamed as National Research Centre for Mushroom (NRCM) by the ICAR for the sake of uniformity. First mushroom mela was organized at NRCM and Solan was declared as mushroom city of India.
14. In 2003, mushroom research lab, Pantnagar was upgraded as MRTC by BOM of GBPUAT, Pantnagar.
15. In the year 2008, NRCM was upgraded as Directorate of Mushroom Research (DMR) by ICAR.

AGRICULTURE & FOOD e-Newsletter

AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Maximizing Crop Yield through CO_2 Fertilization

Article ID: 12056

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Introduction

Most of the following discussion of CO_2 effects on plants applies to species with the C_3 photosynthetic pathway and not necessarily to species with the C_4 pathway. Other aerial, non-biotic environmental factors that affect plant growth and development are light and temperature. Plant photosynthetic rates generally increase linearly with light across relatively low ranges of light intensity, and then the rates decelerate until they reach an asymptotic maximum. Because of crowding and shading of many leaves, most crop canopies do not reach light saturation at full sunlight; that is, they would be able to respond to light levels well beyond full solar irradiance. Likewise, crop photosynthetic rates respond to increasing levels of CO_2 but then level off at higher concentrations (around 700 □ mol/mol or greater, depending upon species and other factors). However, leaf photosynthesis usually increases with temperature up to some maximum value, and then declines. Furthermore, temperature affects not only photosynthesis, but also respiration, growth, development phases and reproductive processes. Elevated CO_2 may have some effects on crop phenology, although stages of development are governed primarily by temperature, time and photoperiod. If dates of planting were to be changed because of the greenhouse effect, then phenological timing of plants could be affected. For example, higher temperatures could decrease yields by decreasing the duration of the grain-filling period or changes in photoperiod could shorten or lengthen the vegetative stage.

The CO_2 fertilization effect begins with enhanced photosynthetic CO_2 fixation. Non-structural carbohydrates tend to accumulate in leaves and other plant organs as starch, soluble carbohydrates or polyfructosans, depending on species. In some cases, there may be feedback inhibition of photosynthesis associated with accumulation of non-structural carbohydrates. Increased carbohydrate accumulation, especially in leaves, may be evidence that crop plants grown under CO_2 enrichment may not be fully adapted to take complete advantage of elevated CO_2. This may be because the CO_2-enriched plants do not have an adequate sink (inadequate growth capacity), or lack capacity to load phloem and translocations soluble carbohydrates. Improvement of photo assimilate utilization should be one goal of designing cultivars for the future (Hall and Allen, 1993). In the process of growth, photo assimilates are allocated to the vegetative shoots, root system or reproductive organs. In some cases, more photo assimilate of CO_2-enriched plants is partitioned to the root system than to the shoots. Above ground, more photo assimilate usually goes into stems and supporting structures than into leaves. This phenomenon may not be an inherent response to elevated CO_2, but may be a by-product of the larger size of plants often found in CO_2-enriched atmospheres, especially by species that produce branch stems along the aerial main stems (Allen *et al.,* 1991).

In climate change scenarios, temperatures are predicted to increase following the rise of CO_2 and other greenhouse-effect gases. Carbon dioxide x temperature interactions have been observed for vegetative growth (i.e., the CO_2 fertilization effect is greater at warmer temperatures than at cooler temperatures). Temperature increases in a higher CO_2 world could increase overall biomass productivity for vegetative crops (pastures and forages) both by extending the length of the growing season in temperate regions, and by the interaction of CO_2 x temperature in stimulation of vegetative growth. However, CO_2 x temperature interactions appear to be very small or negligible for reproductive processes (seed set and seed yield) although there may be more initial flowers formed by greater amounts of branching or tillering that is stimulated by CO_2 enrichment (Baker and Allen, 1993a). Precipitation changes may occur along with other climatic change effects. In general, predictions from crop models show that increased CO_2 should increase productivity of C_3 plants, but the associated predictions of temperature rise will be detrimental. Not surprisingly, changes in precipitation patterns (decreases of rainfall during growth period) could be more detrimental for crop production than changes in temperature.

Under elevated CO_2 stomatal conductance in most species will decrease which may result in less transpiration per unit leaf area. However, leaf area index of some crops may also increase. The typical 40%

reduction in stomatal conductance induced by a doubling of CO_2 has generally resulted in only a 10% (or less) reduction in crop canopy water use in chamber or field experimental conditions. Actual changes in crop evapotranspiration will be governed by the crop energy balance, as mitigated by stomatal conductance, leaf area index, crop structure and any changing meteorological factors. Water-use efficiency (WUE) (ratio of CO_2 uptake to evapotranspiration) will increase under higher CO_2 conditions. This increase is caused more by increased photosynthesis than it is by a reduction of water loss through partially closed stomata. Thus, more biomass can be produced per unit of water used, although a crop would still require almost as much water from sowing to final harvest. If temperatures rise, however, the increased WUE caused by the CO_2 fertilization effect could be diminished or negated, unless planting dates can be changed to more favorable seasons.

Several assessments of impacts of climate change on crop productivity have been published. Progress has been made on integrating the impacts on individual countries and on economic and social interactions. For the most part, these assessments project more favorable climates for agriculture in northern latitudes and less favorable climates in the tropical and subtropical zones. However, the crop modelling predictions are dependent on the scenarios of outputs of General Circulation Models (GCMs) applied to the greenhouse effect. Thus, the dependency chain of assessments follows: Climate Change Scenarios Crop Model Prediction and Agricultural Production Systems (with and without available mitigation and adaptation response strategies) National Scenarios of Economics and Well-being of Farmers, Agricultural Commerce, and Consumers Country-by-Country and Global Interaction Scenarios of World Trade (food and all other commodities). Population Dynamics and Economic Well-being, and Impacts on Social Systems. As the world continues to consume fossil fuels, CO_2 concentrations will continue to rise. Other greenhouse-effect gases, such as methane, nitrous oxides, chlorofluorocarbons and chlorofluorocarbon substitutes, and perhaps tropospheric ozone, will likely rise also.

The CO_2 fertilization effect on plants will increase and climate changes may occur because of the combined increase of all greenhouse-effect gases. Global agriculture could adapt to gradual regional climate changes, but sudden changes would be more serious. Adaptation and/or mitigation actions could include the following:

1. Selection of plants that can better utilize carbohydrates which are produced when plants are grown at elevated CO_2.
2. Selection of plants that produce less structural matter and more reproductive capacity under CO_2 enrichment. (This applies for seed crop plants, not necessarily vegetative biomass plants.)
3. Search for germplasms that are adapted to higher day and night temperatures, and incorporate those traits into desirable crop production cultivars to improve flowering and seed set.
4. Change planting dates and other crop management procedures to optimize yields under new climatic conditions, and select for cultivars that are adapted to these changed agricultural practices.
5. Shift to species that have more stable production under high temperatures or drought.
6. Determine whether more favorable C:N ratios can be attained in forage cultivars adapted to elevated CO_2.
7. Where needed, and where possible, develop irrigation systems for crops.

Precision Agriculture: Site Specific Crop Management

Article ID: 12057

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Introduction

Precision agriculture is the new form of agriculture to maximize crop production and minimize the environmental damage. It is that form of agriculture where site specific management practices are adopted giving due consideration to the spatial variability of land in order to maximize crop production and minimize the environmental damage. In this mode of farming, new information technologies can be used to make better decisions about many aspects of crop production. The goal is not to obtain the same yield everywhere, but rather to manage and distribute inputs on a site-specific basis to maximize long term cost/benefit. Precision farming is helping many worldwide to maximize the effectiveness of crop inputs.

Precision agriculture often has been defined by the technologies that enable it and is often referred to as GPS (Global Positioning System), GIS (Geographical Information System), sensors and yield monitoring in agriculture or variable-rate farming. It only takes a little reflection to realize that information is the key ingredient for precise farming. Farmers who effectively use information can higher returns than those who don't. To be viable, both economic and environmental benefits must be considered, as well as the practical questions of field-level management and Technologies needed. The issues related to precision agriculture include perceived benefits and also barriers to widespread adoption of precision agriculture management.

Objectives

1. To improve crop performance and environmental quality.
2. To manage spatial and temporal variability associated with all aspects of agricultural production.
3. To match resources application and agronomic practices.

Concept of Precision Farming

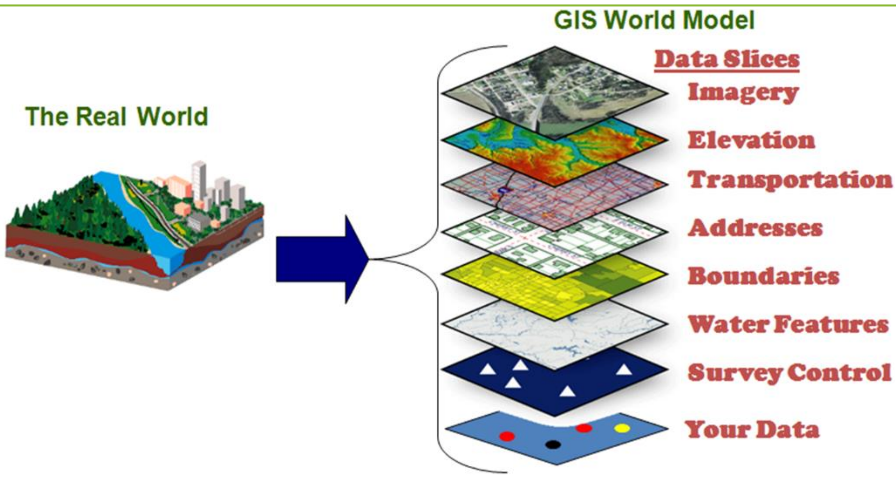
Precision farming is a management strategy that employs detail and site-specific information to manage production inputs precisely. This concept is sometimes called precision agriculture, prescription farming and site-specific management. The idea is to know the soil and crop characteristics unique to each part of the field and to optimize the production inputs within small portions of the field. The philosophy behind precision agriculture is that production inputs (seed, fertilizer, chemicals etc.) should be applied only as needed and where needed for the most economic production.

Components of Precision Agriculture

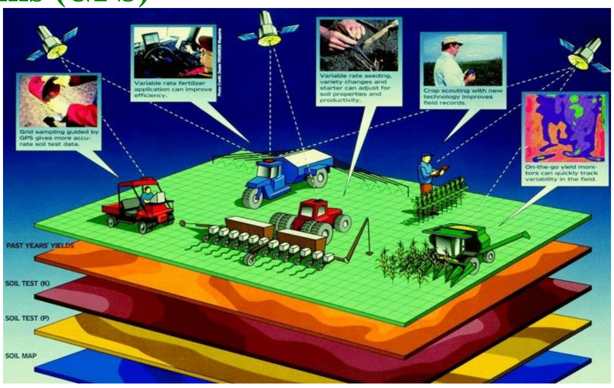
1. Geographical Information Systems (GIS).
2. Global Positioning Systems (GPS).
3. Sensors.
4. Remote Sensing.

Geographical Information Systems (GIS) and its Uses

1. GI is a software that provides data storage, retrieval, and transformation of spatial (field) data.
2. It provides data such as soil type, nutrient levels, etc., in layers and assign that information to the particular field data.
3. Field location is stored by the latitude and longitude of that position.
4. Several maps can be created showing the variability of nutrient levels, soil type, topography, pest incidence and yield.
5. GIS helps in integrating geographical data on various aspects such as soil, weather and field history along with stimulation models.



Global Positioning Systems (GPS)



1. GPS farming systems provide precise guidance for field operations or collect data on tillage applications, planting, weeds, insects and disease infestation, irrigations etc.,
2. Increase farm and farm productive area,
3. Precisely plant seeds at optimal rates at different areas of the field,
4. Save time by performing multiple operations in one pass over the field,
5. Create and maintain detailed records of crops, weeds, insects, disease, topography for prescription farming and water management.

Remote Sensing

1. These may be obtained from soil tests for nutrient availability, yield monitors for crop yield, soil samples for organic matter content, information in soil maps, or ground conductivity meters for soil moisture.
2. Remote sensing imaginary for PF can be obtained either through satellite-based sensors or video digital cameras on broad small aircraft.
3. Using the reflectance in the visible part of the spectrum, it is possible to detect disease and identify weeds from crops.
4. The yield map generated from spectral image can be used to farm managements units.

Advantage of Precision Agriculture

1. Food security: Food security means that each person has a reliable, available and affordable food supply.
2. Sustainability: Anon-negative trend in the productivity of a given plot over time.
3. Increase productivity: Precision agriculture envisages precise package of crop cultivation at micro level which enable to increase the productivity and maintain sustainability.
4. Better utilization of resources.
5. Eco-friendly: The precision agriculture minimizes the environmental damages.

Disadvantage of Precision Agriculture

1. High initial investment: It needs high initial investment for layout and the establishment of assessing and monitoring system.
2. Sampling: Collection of large number of samples is cumbersome as well as costly.

3. Hi-tech nature: Precision agriculture is highly depended on technologies, great skill and latest know how.
4. Need for expertise: Because of its hi-tech and knowledge-based nature, precision agriculture needs sufficient expertise.

Conclusion

Precision agriculture is a recent approach of optimal resources management in agriculture which required for sustainable agriculture and environment protection. In precision agriculture emphasizes on the aspect and deals with judicious crop management at micro level wherein only required amount inputs are applied. Crop requirement of nutrients, nutrient supplying capacity of soil and efficiency of fertilizers are taken into consideration as site specific approach which helps in reducing over application of fertilizers and reduce environment contamination with toxic elements and reduce cost of cultivation.

Rhizobium Natural Biofertilizer for Leguminous Crops

Article ID: 12058

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Summary
Nitrogen is an essential nutrient for plant growth and development. Legumes play an important role in sustainable management of dry arid regions. Most legumes can provide enough nitrogen for their physiological needs. Intensive farming practices that accomplish high yields need chemical fertilizers, which are not only costly, effective and also create environmental problems. Each major legume crop is nodulated by different species of Rhizobium. It is a fast-growing bacterium which is a rich source of nitrogen to the crop. Increasing and extending the role of biofertilizers such as Rhizobium would decrease the need for chemical fertilizers and reduce adverse environmental effects.

Keywords: Rhizobium, legumes, nodules, biofertilizer, nitrogen.

Introduction
Nitrogen is one of the essential elements required for the synthesis of amino acids which, in turn, are used by the plant to form protein. Leguminous plants are also able to utilize nitrogen derived from the symbiotic relationship they form with root nodule bacteria. Legumes play an important role in sustainable management of dry arid regions. Rhizobia are the gram-negative bacteria which have been widely used in agricultural systems for enhancing the ability of legumes to fix atmospheric nitrogen. These inhabit the root nodules of most legumes which can provide enough nitrogen for their physiological needs. Each major legume crop is nodulated by different species of Rhizobium. Intensive farming practices that accomplish high yields need chemical fertilizers, which are not only costly but also create environmental problems. The extensive use of chemical fertilizers in agriculture is currently under debate due to environmental concern and fear for consumers' health. Consequently, there has recently been a growing level of interest in environment friendly sustainable agricultural practices and organic farming systems which include the use of biofertilizers as a substitute of chemical fertilizers. Thus, in the development and implementation of sustainable agriculture techniques. Biofertilization is of major importance in decreasing environmental pollution and the conservation of nature.

Biofertilizer
Bio-fertilizers are commonly referred to products containing microbial cells directed for maintenance and efficient yield of crop, and increased nutrients uptake when mixed with soil. The bio-fertilizers are not only cost effective but also important for management system. The bio-fertilizer moves important nutrient between soil and various plants tissues. Thus, microbes play important role in maintaining plants and soil health. Until now various microbes are studied for bio-fertilizer production. Some of the important microbes and bio-fertilizers are presented here: Rhizobium, azotobacter, azospirillum, phosphate solubilizing microorganisms and agricultural fertilizers.

Rhizobium
Rhizobium is a gram-negative bacterium which inhabits the root nodules of most leguminous crops. Rhizobia are soil bacteria that fix N2 (diazotroph) after becoming established inside root nodules of legumes (Fabaceae). There are several different genera of rhizobia, all of them belong to the Rhizobiales, aprobably-monophyletic group of proteobacteria and they are soil bacteria characterized by their unique ability to infect root hairs of legumes and induce effective N2 –fixing nodules to form on the roots. They are rod shaped living plants which exist only in the vegetative stage. Unlike many other soil microorganisms, rhizobia produce no spores and they are aerobic and motile. Rhizobia (species of *Rhizobium*, *Mesorhizobium, Bradyrhizobium*, *Azorhizobium, Allorhizobium* and *Sinorhizobium*) for intimate symbiotic relationships with legumes by responding chemo tactically to flavonoid molecules released as signals by the legume host. These plants compounds induce the expression of nodulation (nod) genes in rhizobia, which in turn produce lipo chitooligio saccharide (LCO) signals that trigger mitotic cell division in roots,

leading to nodule formation. The legume *Rhizobium* symbiosis is a typical example of mutualism. The *Rhizobia,* which are widely used in agricultural systems, are represented by 7 genera containing about 40 species. Although rhizobia naturally infect legumes as host plants, some *Rhizobium* strains can form symbiotic relationships with non-legumes species such as *Parasponia.*

The Cross-Inoculation Groups Include

1. Clover groups - R. trifolii infects and nodulates plants of genus Trifolium (clovers/trefoil).
2. Alfalfa groups - R. meliloti infects and nodulates the roots of medicago, melilotus and Medicago.
3. Bean group - R. phaseoli infects and nodulates plants of genus Phaseolus (e.g., beans).
4. Lupine group - R. lupine nodulates lupines and serradella (Ornithopus).
5. Pea group - R. leguminosarum infects and nodulates pea, sweet pea, lentil, and vetch.
6. Soybean group - R. japonicum nodulates Glycine such as soybean.
7. Cowpea group - Rhizobium sp. nodulates cowpea, pegionpea, lespedza, groundnut and kudz among a few others.

Biochemical Attributes of Rhizobia

The bacteria Rhizobia are grow aerobically using various sugar types like pentose, and hexoses as a source of carbon. Similarly, they use nitrogen in the form of nitrates (NO3) or ammonia (NH3). However, molecular nitrogen (N2) is believed to be a causative in utilization by this specie and so their multiplication does not occur. However, Rhizobium in nodule undergoes transformation. Hence, adopted a larger, may appear in X and Y shaped and may possess the ability to reduce molecular nitrogen and that's why called as bacteroid (Blondeau, 1981). In order to get reasonable biomass of this bacterium, vitamins and some growth promoting factors are needed by different strains of Rhizobium. On morphological perspective, Rhizobia are rod shaped (2 μm) long and 0.5-1 μm wide, motile and gram negative in free living form. For isolation and characterization of Rhizobium in the soil is done through the host legume (Blondeau, 1981).

Conclusion

Information from the various literatures depicts that association between *Rhizobium* and legumes or some non-leguminous plants is a natural phenomenon. Progressive knowledge of this area may bring benefits for using this technology. Therefore, more research is needed on the interaction between crops and rhizobia or rhizobia-like bacteria.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

A Short Review on Xanthan Gum

Article ID: 12059

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Introduction

Gum is the popular term for hydro colloidal gels-polysaccharides having an affinity for water and presenting binding properties with water and other organic/inorganic materials. Many researchers have derived gums from a wide variety of plants. Since polysaccharides are present in all life forms, gums can also be derived from fermentation of sugar by microorganism. Microbial polysaccharides are composed of regular repeating units of simple sugars like glucose, mannose, fructose, etc. and so are sometimes termed as slime or exo-polysaccharides. Dextran, discovered in early 1940s, was the first microbial polysaccharide to be commercialized. Xanthan gum (XG) was the second microbial gum commercialized which was produced by *Xanthomonas campestris* (a Gram-negative bacteria genus that exhibits several different species) having wide applications in various industrial and biomedical applications such as food and food packaging, cosmetics, water-based paints, toiletries, petroleum, oil-recovery, construction and building materials, and drug delivery. This bacterium (Fig. 1A) discovered on cabbage plants was found capable of producing an extracellular polysaccharide with excellent rheological properties in 1961 by the United States Department of Agriculture (R Badwaik *et. al.,* 2013).

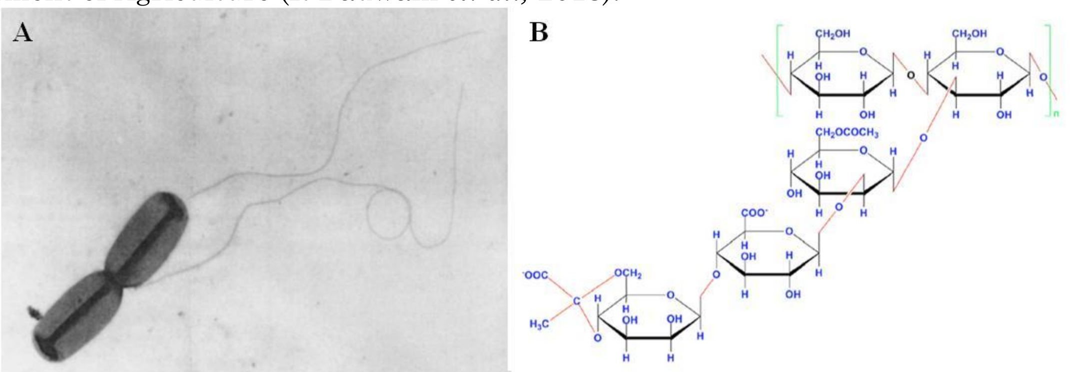

Fig. 1: (A) Transmission electron micrograph of *Xanthomonas campestris* (x12000) picture was taken from Garcıa-Ochoa *et. al.,* 2000. (B) Structure of Xanthan Gum.

Structure and Property of XG

The primary structure of XG shown in Fig. 1(B) has a tri-saccharide side chain connected to alternate D-glucosyl residues and is made up of 1, 4-linked β-D-glucose residues (Jansson *et. al.*, 1975). The side chains are β-D-mannose-1, 4-β-D-glucuronic acid- 1,2-α-D-mannose, with the internal mannose being typically O-acetylated and the terminal mannose being replaced by a 4, 6-linked pyruvic acid ketal. The molecular weight of XG is approximately 2 x10^5 g/mol, but it can go as high as 13-50 x10^5 (Dintzis *et. al.,* 1970). XG is extremely soluble in cold and hot water with ability to have high viscosity even at low polymer concentrations. It is non-toxic, does not inhibit growth and approved by the United States Food and Drug Administration (FDA) for use in food additive without any specific quantity limitations (Kennedy and Bradshaw, 1984).

Process of Xanthan Gum

Firstly, the selected microbial strain was maintained with desired properties for possible long-term storage. These small quantities of preserved culture are expanded to produce inoculum for large bioreactors with growth on solid surfaces or in liquid media. Inside the bioreactor, the inoculum was provided with proper medium and conditions favourable for the growth of *Xanthomonas campestris* and allowed to ferment (Fig.2).

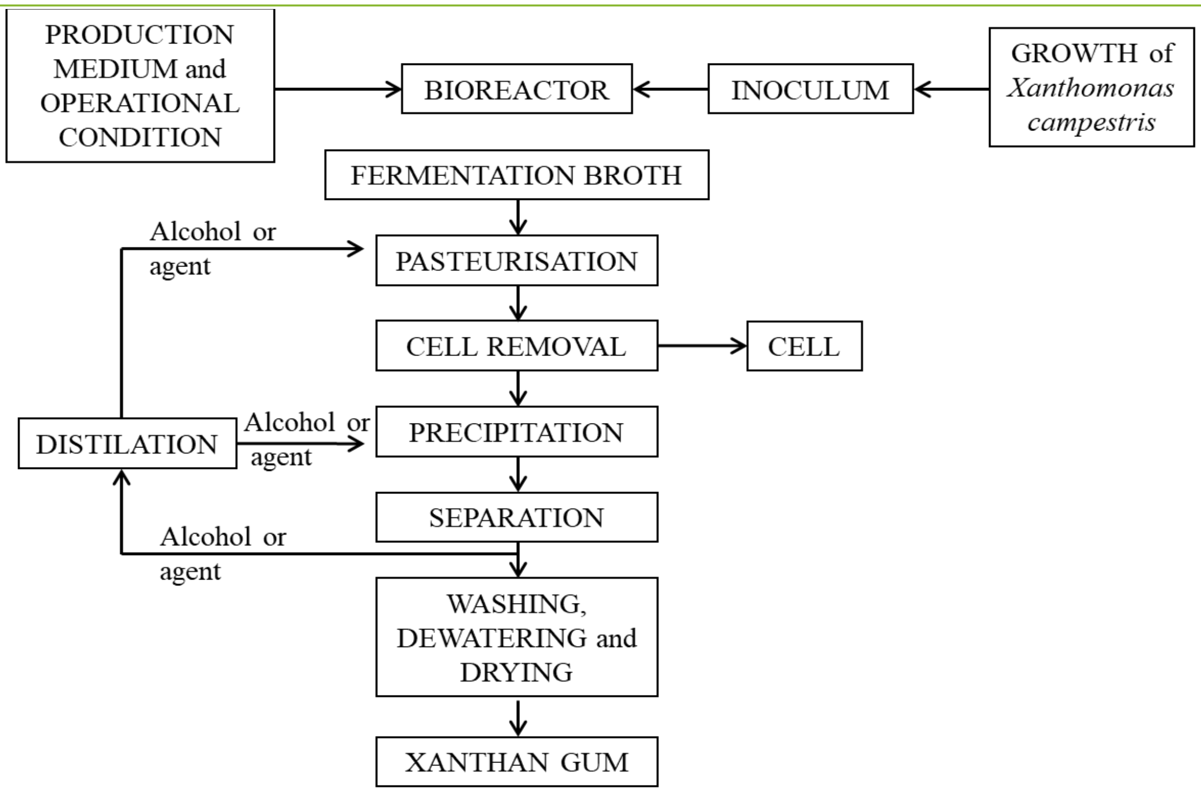

Fig. 2: Outline of Xanthan Gum production process

The broth contains xanthan, bacterial cells, and a variety of other compounds towards the end of the fermentation process. The cells are normally removed first, either by filtration or centrifugation, in order to recover the xanthan (Flores Candia and Deckwer, 1999). Further purification techniques include precipitation with water-miscible non-solvents (isopropanol, ethanol, and acetone), addition of particular salts, and pH adjustments (Flores Candia and Deckwer, 1999). Precipitation with water-miscible non-solvents (isopropanol, ethanol, and acetone), addition of specific salts, and pH modifications are all options for further purification (Flores Candia and Deckwer, 1999). The use of isopropanol for precipitation is required by FDA rules for food grade XG. The product is mechanically dewatered and dried after precipitation. The dried product is processed and put into low-permeability water-resistant containers.

Uses of Xanthan Gum

Xanthan gum is water-soluble microbial polymer known to exhibit unique rheological properties which leads to extensive commercial applications.

Agriculture: XG has been widely used in the agricultural sector to improve the rheological and flow qualities of insecticides, fungicides, and herbicide formulations by uniformly stabilising insoluble components. As a result, it aids in the regulation of spray float and adherence, extending the contact period between the pesticide and the agricultural plants (Palaniraj and Jayaraman, 2011). Another noteworthy agricultural application discovered by XG is the regulated release of KCl fertiliser for water retention purposes in various soil samples (Singh and Dhaliwal, 2020).

Pharmaceutical Industry: XG stabilizes suspensions of a variety of insoluble materials such as barium sulfate (X-ray diagnoses), complexed dextromethorphan (for cough preparations) and thiabendazole. Kim *et al.,* (2015) developed XG-based chlorhexidine biopolymers as a drug carrier for antiseptic medication delivery. The production of physical and chemical networks by XG high molecular weight allows it to be used in the preparation of prospective hydrogels for drug and protein carriers, as well as scaffolds for cells (Petri, 2015).

Food Industry: The food industry uses XG as an emulsifier and thickening ingredient in a wide range of goods, including juice, fruit pulp and powder beverages, chocolates, sweets, jellies, dairy products, margarine, yoghurt, bread products, frozen foods, sauces, and gravies.

Mix with other Gums: To lower production costs, XG is combined with other gums such as locust bean gum or guar gum.

Oil extraction: Enhanced oil recovery is yet another key application of XG. The gum generates a high viscosity solution with pseudo plasticity even at low concentrations. Because the oil is retained in the tiny pores of the small sand stone, a XG solution must be pumped into the rocks to ensure efficient oil extraction.

Paints and Coating: XG could be an excellent choice as a key ingredient in paint and coating compositions, providing thickening capabilities and stable insoluble ingredient suspensions throughout storage. Furthermore, xanthan gum's pseudoplastic nature and rheological qualities can provide desired textural properties in ceiling tile coatings as well as good wall adhesion when applied with a brush, roller, or spray (Palaniraj and Jayaraman, 2011).

Conclusion

Xanthan Gum is a widely used gum in variety of industries, including agriculture, food, pharmaceuticals, oil extraction, and paint and coatings. The majority of gums are plant-based, and their production is influenced by nature and the environment. In terms of XG production, India lags considerably behind other countries leading to utilization of gum from other sources. Hence the need to produce affordable xanthan gum and its commercialization has to be addressed and there is a need to improve production from cheap raw materials to make them effective one.

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Techniques for High Quality Potato Seed Production

Article ID: 12060

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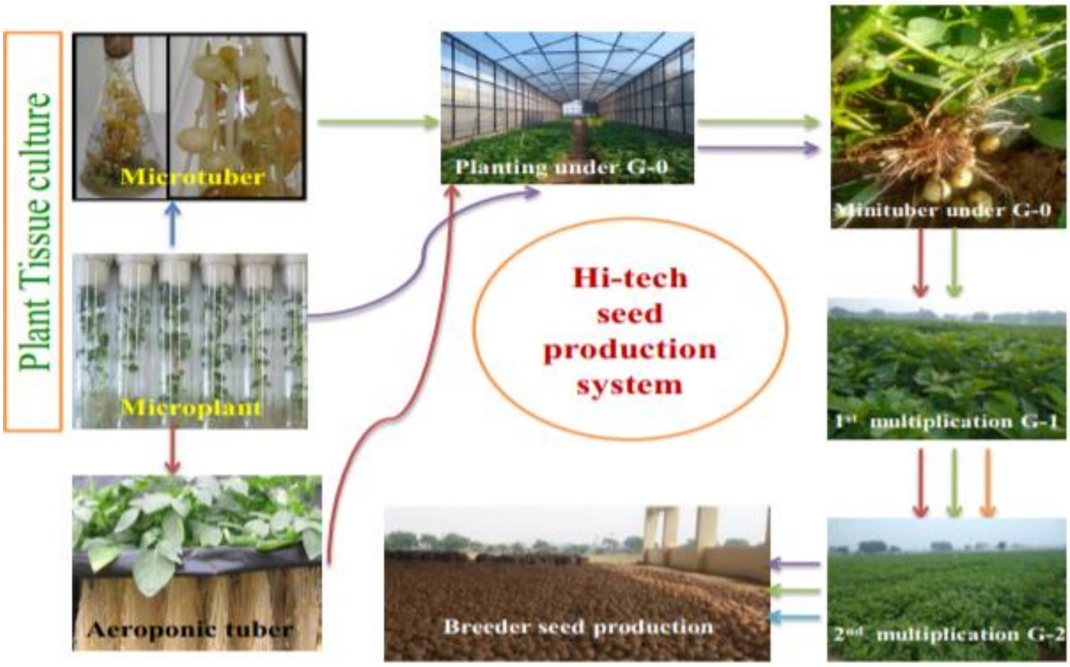
Introduction

Availability of quality planting material has always been a limitation in vegetatively propagated crops. Potato, largely being a vegetatively propagated crop, is subjected to large number of seed-borne diseases responsible for yield degeneration. Hence, it is imperative to use good quality healthy seed for sustainable and economic production of potato. Hi-tech potato seed production is based on tissue culture technique. This technique enables large scale multiplication of healthy plant round the year which is not possible under conventional system. This system is also aimed at reducing the field exposure and thereby minimizing the accumulation of viruses in the seed stocks. This system can be further sub-divided into three system viz. seed production based on i) microplant ii) micro-tubers and iii) aeroponics iv) apical rooted cutting.

Microplant Based Seed Production System

Viruses and seed-borne diseases should not be present in the mother tuber of a known variety. Before initiating *in vitro* culture, the mother plant raised from mother tubers should be virus-free tested using all available methods. ELISA, ISEM, PCR, NASH, and other techniques are among them. The virus-free stocks are multiplied up to 10-12 cycles using nodal cuttings on semisolid MS medium. After that, the *in vitro* plantlets are hardened for 8-10 days under the right conditions. Hardened plantlets should be removed from portrays with peat moss and transplanted in rows at appropriate spacing on nursery beds in a mixture of soil, sand, and FYM under insect-proof net house conditions. ELISA testing is done on 5% of the plants. Minitubers are the seeds produced by the microplant (G-0). Generation-1 minitubers weighing more than 3 g will be planted in the field the following season. G-1's output is multiplied again into the field (G-2). The G-2 produce is sold as breeder seed.



Seed production through hi-tech systems

Microtuber Based Seed Production System

In controlled conditions, microtubers are induced on the microplant. 3-4 weeks old microplant shoot cuttings are transferred into 250 ml conical flasks or culture bottles containing 25-35 ml liquid medium to induce microtubers. In the culture room, the cultures are then incubated at 250°C with a 16-hour photoperiod. Decant the medium and replace it with tuber induction medium. The plant is then incubated in the dark for two to three months in order to produce microtubers. Hardened microtubers are used to raise seed crops in net houses in G-0, G-1, and G-2, with G-2 being supplied as breeder seed.

Aeroponic Based Seed Production System

Adopting aeroponic technology, which can increase the multiplication rate from 5:1 to 50:1, has enormous potential for increasing healthy seed production. Aeroponics is the process of growing plants without the use of soil or aggregate media in an air mist environment. We don't need any extra space to produce healthy seeds using an aeroponic system. Only 1% of conventional water usage, which is essentially recycled water, is required. It is the ideal technology for producing high-quality seed at a low cost. In this system, the plant's roots are grown in complete darkness in a light-proof sealed box or container, with the roots being misted with nutrient solution on a regular basis. The nutrient solution is constantly recirculated throughout the system, and it is monitored and amended as needed. The plant's top portion is exposed to air and a light source. It prevents plantlets from being exposed to unfavourable soil conditions, and the minitubers harvested from this system are pathogen-free. Desired size of minitubers can be harvested sequentially which are further multiplied in G-0, G-1 and G-2 and G-2 supplied as breeder seed.

Thus, high-quality nucleus and breeder seed stock are produced under strict supervision using the method as described above. After that, standard seed plot techniques developed by CPRI for quality seed production are used for further multiplication in different stages. CPRI's breeder seed is distributed to various state government organisations for further multiplication in three more cycles, namely Foundation-1, Foundation-2, and Certified seed, in accordance with the Seed Act.

Apical Root Cutting (ARC)

An emerging technology of quality seed potato production.

Seed production through apical root cutting

In today's potato production seed systems, apical cuttings are an alternative to minitubers. Apical cuttings are rooted transplants made from tissue culture plantlets in a glasshouse. Tissue culture plantlets are used as mother plants in cocopeat to produce cuttings in apical cuttings. In six weeks, one mother plant can be multiplied to produce 8 plants. These cuttings are transplanted to a seed bed and then moved to net houses or open fields to produce seed tubers once they have rooted. This technology works by removing the apical bud from plantlets, allowing the lateral buds to grow and produce new shoots due to the lower IAA concentration. When the plant's apical dominance is removed, elongation and lateral growth are encouraged, and the lateral buds develop into new branches, which are then used to boost the multiplication rate. Apical cuttings involve: i) Production of rooted cuttings (transplants) originating from tissue culture plantlets in the glasshouse. ii) Production of seed tubers in the field from transplants. ARC have the potential to transform potato seed systems through rapid and high rate of multiplication and will significantly contribute to reducing seed potato shortages.

Conclusion

In order to increase yield potential, high-quality seed is important in potato production. In India, conventional and high-tech systems are used to produce basic seeds. Apical root cuttings (ARC), a novel technique, has the potential to transform potato seed systems by allowing for rapid and high rates of multiplication, and can be used to supplement the country's seed potato demand.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Recent Advances in Attract-and-Kill for Agricultural Pest Management: Beyond Pheromones

Article ID: 12061

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Introduction

The pesticides are long relied for management of agricultural crop pests, which usually target the immature insects to makes it economically and are also often ecologically disruptive. These are also less compatible to other IPM strategies (way *et al*., 2000). Unfortunately, few alternatives like, semiochemicals and pheromones were often considered as best alternative and are also comparably effective. One of the approaches of semio-chemical is attract and kill which are used for pest monitoring, behavioural manipulation etc. Semio-chemicals attractive to females are usually also attractive to males. Recent developments in attract-and-kill have involved the applications of kairomones, especially the plant volatiles and compounds derived from plant–microbe interactions. While the concepts of attract-and-kill with such substances are quite old, enhanced understanding of the fundamental science of insect attraction to kairomones has the expanded possibilities.

Attract and Kill

Combination of attractant and killing agents which paired with trapping devices. Other names include mass trapping, lure-and-kill and attracticide (Suckling *et al*., 2000).

Sensory Mechanism and Attractive Agent

Insects perceive the plant volatiles with their olfactory response of receptor neuron which reformatted for passage to higher brain centres (Deisig *et al*., 2010). Visual, tactile and gustatory stimuli are also involved in behavioural response to plant. Visual are important in close range as well as the olfactory for long range response.

Initially, biological based bioassay and field test will be carried out with electroantennograms, wind tunnels or olfactometers to prove the attractiveness of compound, but due to the environmental conditions and other ecological factors can affect the response criteria. While working with plant and microbial volatile compounds, which proved that the blends of volatile compound are often more attractive than single one. The plant volatile mix with pheromone increases the catches of males, but the plant volatiles can be used for monitoring when pheromones are not useful, as in orchards subjected to mating disruption. However, there are also examples where, plant volatiles inhibit the responses to pheromones. For attract-and-kill, addition of pheromones to plant volatile blends might not always improves the efficacy. An alternative to the unique volatile hypothesis is the ratio-specific hypothesis, which led to the development of blends that mimic the volatile profiles and contract to super blending (Gregg *et al*., 2010).

Killing Component

Mostly, the insects are mass trapped and killed by chemicals, dehydration and solar radiation. In attract-kill method, the sprayable includes the toxicant with few plants' volatile are toxic enough to kill insect pest and also not environment disruptive to non-target organisms (Del Socorro et al., 2010). Toxicants for sprayable may have contact activity, stomach activity or both. Generally, the killing agents used in these methods were permethrin, cypermethrin and bifenthrin, neonicotinoid imidacloprid, spinosad, methomyl and thiodicarb. Pathogens such as *Metarhiziumanisopliae* can also attract and contaminate the devices, in that case objective is not the immediate death of trapped insect but its release with the aim of spreading the pathogen in the wider population.

Impact on Non-Target Organism

Attract-and-kill can pose dangers to non-target organisms (predators and parasitoids, pollinators, aquatic organisms and vertebrates.), when toxicants are presented in combination with materials that are potentially attractive to them.Non-target arthropods may perceive and respond to the individual plant volatiles used in attract-and-kill and herbivore-induced plant volatiles (HIPV's) can be attractive to predators and parasites. Eg: Kairomones attract the parasitic wasp; traps baited with the microbial compounds' acetic acid and 3-methyl-1-butanol collected species of moths and pollinators such as honey bees. For concentration of sugar and time of application of attractant helps in limiting the pose of non-target organisms.

Attract-and-Kill in IPM Program

Attract-and-kill can be combined with the resistant plants in IPM. Attraction from synthetic plant volatiles or extracts, or from living plants can be combined with repellence from similar sources in push–pull systems (Pickett *et al*., 2008). In many push–pull systems, the attractant (pull) is not combined with a toxicant. The aim is not the destruction of pest populations but rather their redistribution to hosts or locations where, they are less damaging. A novel use for the same product in resistance management for transgenic cotton is its application without insecticide, to encourage oviposition on refuge crops, increasing numbers of susceptible insects.

Future Aspect

Economics and delays associated with the registration can be a serious obstacle in the development of formulated attract-and-kill products, especially since this are typically developed by small companies together with public sector research organizations rather than by large transnational agrochemical companies. However, the challenges and constraints in registration continues and they dampen the research and development efforts. These can overcome by the developers of the technology, patience, foresight, clever marketing and understanding of the need of farmers are the qualities that will be essential.

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E-ISSN: 2581 - 8317

Biofortification: A New Approach to Nutritive Food Production

Article ID: 12062

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Introduction

Increase in population, inadequate food supply and nutrition, hunger, malnourishment etc. are one of the biggest challenges to address most of the nations across the world. Deficiency of mineral is one of the main global challenges to human health. It is called "Hidden hunger", resulting in poor growth and compromising psychomotor development of children, lesser immunity, weariness, irritability, weakness, loss of hair, muscle loss, sterility, and death. Vitamin A and zinc deficiencies to approximately cause 600,000 and 400,000 deaths annually respectively. Iron and zinc deficiency are the most common and widespread, excruciating more than half of the human population. As per **FAO**, a balance diet of 300 gms of vegetables (125 gms green leafy vegetables, 100 gms of tubers and 75 gms of other vegetables) to be consumed daily. However, though the per capita consumption of vegetables has increased from 87.66 g in 1951 **(Vanitha et al. 2013)** to 357 g in 2017 still 20 to 50 per cent deficient as recorded to various groups of society.

Consuming vegetables plays an important role in a balance diet as these commodities are rich in vitamins, antioxidants as well as phytochemicals. A number of vitamins such as A, C, E, along with carotene are exceptional antioxidants, which also contribute to good health through other mechanisms, such as being co-factors for certain enzymes, and their involvement in oxidation-reduction reactions **(Weisburger 1999, Podsedek 2007)**.

Traditional agricultural practices can partly enhance the nutritional content in vegetables but biofortification is a practice of nutrient fortification in food crops using agronomic, conventional and transgenic breeding methods to provide a reliable and long-term programme which addresses negative impact of vitamin & nutrient deficiencies.

What is Biofortification?

Biofortification can be defined as the development of micronutrient-dense staple crops (cereals and vegetables) using traditional plant breeding practices, modern biotechnology, and agronomical approach. In this process, the assemblage of plant-derived nutrition and vitamin is increased in the edible organ during growth and development of the plant **(O'Hare 2015).** Biofortified staple food may not contain a high level of essential vitamins and micronutrients as compared to industrially fortified foods, but they can help to reduce "hidden hunger" by increasing the daily suitability of micronutrients uptake by the individual throughout the life cycle.

Strategies of Biofortification in Vegetables

In general, three complementary strategies can be employed to increase mineral concentrations in edible crops:

1. Agronomical biofortification.
2. Conventional breeding.
3. Genetic engineering.

Biofortification through Agronomical Methods

Agronomical biofortification engage methodology of fertilizer application or ferti-fortification through seed treatment, foliar application and use of organic manure to increase nutraceutical values as these are less expensive and fast methods for boosting mineral contents in various vegetables.

A major constraint for agronomical biofortification is lowered phytoavailability of nutrients in the soil. Most favourable micronutrient for agronomic fortification are Selenium, Zinc, Iodine, Copper etc. Application of nutrients to fortify plants is done through foliar spray of ZnSO4 or through soil application of iodide or selenate. Mycorrhizal consortium increases the uptake and regulation of micronutrients like Se, Fe, Cu and Zn in crops.

Tomato-Plants can tolerate high level of iodine, stored in vegetative tissues and fruits in surplus amount for human diet and hence are an excellent crop for iodine-biofortification program. Using environmentally safe new generation organic fertilizer such as "Riverm" for enriching Solanace crops like tomato, chilli, brinjal with zinc **(Bouis*et al.,* 2011).**

Potato-Foliar application of zinc improves Zn concentration in potato was reported by **White *et al.,* (2012).**

Amaranthus-*Amaranthus gangeticus* leaves are a rich source of Zn, Fe, Ca, Mg and Cu. ***Spirulina platensis*** is a microbial inoculant used as a biofortifying agent to intensify iron level of crop **(Kalpana *et al.,* 2014).**

Se-enriched ***S. pinnata*** used for enriching broccoli, carrots and onions with healthful forms of organic-Se by foliar application of a solution of 77Se (IV).

Using Conventional Breeding Methods

Conventional breeding practices help in improving the concentration of β-carotene, carotenoids, amino acids, amylase, carbohydrates and other minerals through making proper selection of breeding material to increase nutritional efficiency. This is an ecologically and economically stable process of crop development for nutraceutical values of the food.

Potato: Kufri Neelkanth Antioxidant rich table purpose variety. Tubers are dark purple black in colour, ovoid in shape with medium deep eyes, creamy flesh, good storage capacity, medium dry matter (18%) and medium dormancy with outstanding flavour. Suitable for growing in North Indian plains developed from CPRI, Shimla. (Source: icar.org.in).	
Brinjal variety: Pusa Safed Baigan 1' Released by IARI in 2018. White coloured oval fruit rich in total phenol content and high antioxidant property.	
Cauliflower: Pusa Beta Kesari 1 (Pure line variety) Country"s first biofortified cauliflower. Contains high β-carotene (8.0-10.0 ppm) in constrast to negligible β-carotene content in other popular varieties. Developed by ICAR, New Delhi in 2015.	
Sweet potato- Bhu sona- High β-carotene (14.0 mg/100g) • Tuber yield: 19.8 t/ha • Dry matter: 27.0-29.0% • Starch: 20.0% • Total sugar: 2.0-2.4% Bhu Krishna- Rich in anthocyanin(90mg/100g) • Tuber yield of 18.0 t/ha • Dry matter: 24.0-25.5% • Starch: 19.5% • Total sugar: 1.9-2.2% • Salinity stress tolerant • Adaptation for Odisha.	

	
Carrot- Pusa Rudhira- The variety has higher level of Carotenoid (7.14mg) & Phenol (45.15mg)/100g.Possess antioxidant property self-core red coloured with delayed bolting. Pusa Asita- self black coloured roots Late bolter. Rich source of anthocyanin.	 
Raddish- pusaGulabi- First Pink fleshed variety High in total caroteniods, anthocyanin and ascorbic acid content. Grows exceptionally well in heat of summer. Medium root size, cylindrical shape	
Pusa jamuni- First purple fleshed nutritionally rich variety high in anthocyanin & ascorbic acid content	

Use of Transgenic Techniques

Genetic engineering techniques utilize an unlimited pool of genes to produce new cultivars through transfer of desirable characters from one organism to another to develop elite cultivars, thereby improving its value.GE techniques have conquered new phases of multiple gene transfer which helps in enhancing the level of provitamin A, vitamin B9, folate, ascorbate to identify promising lines. Some distinct micronutrients can be naturally produced in crops.

Carrot- Bio-available calcium content in transgenically modified carrots was found to increase by the Arabidopsis H+/Ca2+ transporter CAX1 thus Ca content reduce the incidence of osteoporosis.

Cauliflower-Map based cloning done by isolating copia-like LTR retrotransponson or gene to regulate caroteniods accumulation and increased the level of ß-carotene in mutant orange cauliflower.

Sweet Potato-It is an alternate source of energy, rich in antioxidants, anthocyanin and dietary fibres. The content of lutein and caroteniods was increased by expressing orange IbOr-Ins gene in white fleshed sweet potato.

Tomato-To increase the content of Lycopene, anthocyanin, flavonols and antioxidant content in tomato the following genes were expressed to produce transgenic tomato.

Future Challenges

1. Crop production with increased iron concentration.
2. Improving efficiency with which minerals are mobilized in soil.
3. Enhancing mineral uptake efficiency of important crops.

Conclusion

Hunger and malnutrition are major issues which need attention on priority. Nutraceuticals biofortified vegetables are having potential to handle these issues. It is one of the eco-friendly and cost-effective possible solution. Development, production and consumption of such vegetables need to be popularized for preventing and controlling various health issues. Agronomic biofortification, use of conventional breeding methods as well as transgenic approaches are most common methods of improving nutraceuticals properties in various vegetables. Restrenthening the augmentation, collection and evaluation of germplasm, development of hybrids, varieties, to induce mutants with higher nutritional values, exploitation of molecular biology and cellular genetics, close interaction between nutritionists and breeders to increase awareness, strengthening research on indigenous vegetables are the necessary steps to enhance biofortification of Nutraceuticals in vegetable crops.

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Green House Perennial – *Coleus blumei* (Nettle Leaf)

Article ID: 12063

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Common name: Stove nettle or Nettle leaf.
Family: Labiatae.
Type: Green House Perennial.
Mature size/ shape: 45cm high, 30cm or more across.

Grown for its leaves rather than its flowers, the coleus can be relied on to produce a magnificent display of colour almost the whole year round. The leaves come in many varied shades of bronze, yellow, apricot, pink and crimson, and make a striking change from the more usual foliage colours. In recent years even more colourful strains have been developed such as the Japanese variety, Kimono, with its attractive fluted and divided leaves. It is no wondered that coleus is often known simply as 'the foliage plant'.

Coleus is a native of Java, but was well known in Europe by the 19th century, when it was widely used by the thousand in formal bedding arrangements. Its name derives from the Greek *Koleos*, meaning sheath, a reference to the way the stamens are enclosed.

Pinching out the growing tips will encourage the plants to produce more leaves and bush out to really good effect. One plant can achieve a spread of up to 30 cm, so that a group of three or four together will fill your windowsill with colour for most of the year. The flowers that are pale blue and rather insignificant and appear at the tips of the stalks should be nipped off as soon as they start to show. If the flowers are allowed to remain, the growth of the plants suffers and it will die prematurely.

Coleus is sometimes propagated from cuttings, rather than seed. Take about 7-8 cm from the top of non-flowering shoot, cut it just below a leaf joint, remove all except the top two leaves and root it in a small pot filled or an even mixture of peat and sharp sand. Move it to successively larger pots as it grows, until settling it finally in the ideal size an 18 cm pot.

Cuttings can be taken either in early in early autumn or mid spring, but in both cases, care must be taken that the winter temperature does not fall below 15°c. Don't be alarmed if the leaves of your cutting fade during the winter – the colors brighten again with longer hours of daylight.

				
Stained Glassworks Kiwi Fern	**Rustic Orange**	**Fishnet Stockings**	**Wizard Mix**	**Henna**

				
Trailing Plum	**Black Dragon**	**Limelight**	**Picture Perfect Salmon Pink**	**Big Red Judy**
				
Super-Fine Rainbow Festive Dance	**Premium Sun Chocolate Covered Cherry**	**Wizard Jade**	**Wizard Velvet Red**	**Wizard Coral Sunrise**
				
Superfine Rainbow Masterblend Mix	**Superfine Rainbow Festive Dance**	**Giant Exhibition Magma Coleus**	**Giant Exhibition Rustic Red Coleus**	**Giant Exhibition Palisandra**
				
Premium Sun Crimson Gold	**Premium Sun Dark Chocolate**	**Premium Sun Watermelon**	**Premium Sun Pineapple Surprise**	**Kong Rose Coleus**
				
Fairway Yellow	**Fairway Orange Coleus**	**Fairway Mosaic Coleus**	**Rainbow Mix Improved**	**Kong Lime Spritebur**

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E-ISSN: 2581 - 8317

Switch to Plant Growth Promoting Rhizobacteria for Sustainable Agriculture

Article ID: 12064

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The Plant Growth Promoting Rhizobacteria (PGPR) are heterogenous group of soil inhabiting bacteria that colonize plant roots, ameliorate the plant growth and reduce disease and pest damage to plants. Due to rising concern about the harmful impacts of chemical pesticides on human and environment, the PGPR is picking up the momentum as phytostimulant, phytoremediant, biofertilizer and as an antimicrobial agent. Furthermore, these PGPRs also impart abiotic stress tolerance (drought, salinity and heat) to plants which are common due to climate change. The PGPR comprises of various bacterial genera such as *Azospirillium, Azotobacter, Bacillus, Pseudomonas, Burkholderia, Klebsiella, Enterobacter, Arthrobacter* and *Serratia,* etc. They are grouped into two categories: Intracellular PGPR and Extracellular PGPR. The intracellular PGPR (iPGPR) resemble the nodule-forming bacteria and live inside the plant cells i.e., *Agrobacterium, Erwinia, Bacillus, Azotobacter*, *etc*. The extracellular PGPR (ePGPR) are free living and live outside the plant cells *i.e., Mesorhizobium, Bradyrhizobium, Rhizobium*, *Mesorhizobium*, *Frankia* and endophytes.

Mechanisms of PGPR

1. Direct Mechanism: It plays direct role in plant growth and shows biofertilizer activity. The various direct mechanisms are: Nitrogen fixation, Phosphate solubilization, Potassium solubilization, Siderophore production and Phytohormone production

2. Indirect Mechanism: It plays indirect role in plant growth and shows biocontrol activity. The various indirect mechanisms are: Antibiotic production, Hydrolytic enzyme production, Induced systemic resistance and Exopolysaccharide production

Direct Mechanism (Growth Promotion)

1. Nitrogen Fixation: The nitrogen is most vital nutrient for plant growth. Although, there is 78% nitrogen in the atmosphere but it is not available to the plants. The atmospheric nitrogen is converted into plant utilizable nitrogen by nitrogen fixing microorganisms. There are two mechanisms for nitrogen fixation i.e., symbiotic nitrogen fixation and non-symbiotic nitrogen fixation. The symbiotic nitrogen fixation is carried by *Rhizobium, Mesorhizobium, Bradyrhizobium, Sinorhizobium* and *Frankia* which live in symbiotic association with the plants. However, non-symbiotic nitrogen fixation is carried by free living organisms like *Azospirillum, Acetobacter, Azotobacter, Diazotrophicus* and *Pseudomonas*.

2. Phosphate Solubilization: Phosphorus is the second important nutrient for plant growth after nitrogen. Despite being the large reservoir of phosphorus in the soil it is inaccessible to the plants. The majority of the soil phosphorus is present in the insoluble form as inorganic or organic mineral in the soil. The phosphate solubilizing bacteria such as *Bacillus, Beijerinckia, Erwinia, Azotobacter, Enterobacter, Burkholderia, Rhizobium* and *Pseudomonas*, etc. convert insoluble phosphorus into soluble form of phosphorus and make it available to the plants.

3. Potassium Solubilization: Most of potassium in soil is present in form of insoluble rocks. PGPRs can solubilize potassium rock by production of organic acids.

4. Siderophore Production: Iron is essential nutrient for all organisms. In the aerobic environment, the iron is present in the form of Fe^{3+} and form insoluble oxides and hydroxides, thus making it unavailable to the plants and microorganisms. The bacteria produce unique compounds called siderophores to acquire this iron. These siderophores are low molecular weight iron chelating compounds, thus acting as solubilizing agents of insoluble iron under iron limited conditions.

5. Phytohormone Production: PGPRs produces plant harmones like Auxin, Gibberellin, Cytokinin and Ethylene which leads to plant growth.

Indirect Mechanism (Biocontrol Activity)

1. Antibiotic Production: PGPRs produces myriads of antibiotics which suppress the plant pathogens to grow. The antibiotics like Phenazines, 2,4-Diacetylphloroglucinol, cyclic lipopeptides are produced by Pseudomonads. The *Bacillus and Streptomyces sp.* produces oligomycin A and xanthobaccin.

2. Hydrolytic Enzyme Production: PGPRs secretes various enzymes like ß-glucanase, chitinases, lipases, dehydrogenase, phosphatases and proteases which suppress plant pathogens like *Pythium, Phytophthora sp., Rhizoctonia solani, Botrytis cinerea, Sclerotium rolfsii, etc.*

3. Induced Systemic Resistance (ISR): PGPRs induces systemic resistance in plants which helps plants in combating with the diseases.

4. Exopolysaccharide Production: PGPRs produces substances which are deposited outside the cell wall called exopolysaccharide. These helps in root colonization, biofilm formation, shielding from desiccation, protecting from foreign pathogens, circulating essential nutrient to the plant, etc.

The PGPRs have multifaceted action like growth promotion, bioremediation, abiotic stress tolerance and biopesticides. The efficacy of these can be further enhanced with more research pertaining to specific soil conditions and host. In near future, they are likely to replace the synthetic fertilizers, artificial growth regulators and agrochemicals which have harmful side effects to environment. The performance of these PGPRs is inconsistence in the field, although they are doing well in lab and glasshouse experiments as they as specific to soil condition and host. Further research is demanded in this area to explore the more competent rhizobacterial strains for diverse agro-ecological conditions.

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E-ISSN: 2581 - 8317

Paper-Based Biosensor: Disposability, Biodegradability and Cost Effectiveness

Article ID: 12065

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Introduction

The paper-based biosensor is a type of biosensors which require minimal instrumentation and fulfill the demand for low cost, point-of-care biosensor. Paper has excellent characteristics for biosensors because of its mechanical properties such as lightness, flexibility and stiffness, and absorbency, air permeability, capillary action, and a high surface-to-volume ratio.

Apart from the low cost of paper-based biosensors, it is highly biodegradable and disposable which ultimately reduces the agricultural and environmental hazards. These hazards are different in nature such as physical, chemical, and biological.

Chemical compounds such as metal and organic matter, and biological compounds such as viruses, pathogen bacteria, etc. can contaminate the ecosystem of an area by penetrating water, soil, and air remaining in the environment and entering the human life cycle through inhalation, skin absorption, and swallowing (Bordbar *et al.,* 2021).

Since very low concentrations of any toxin substances can pose serious hazards, it is important to detect them using a sensitive method. The detection is carried out in a real sample consisting of thousands of chemical species. Therefore, the detection method needs to be highly selective.

The paper-based biosensor can be classified into two categories:
1. Electrochemical sensor.
2. Optical sensor.

Electrochemical sensors are devices that provide real-time information on the composition of a system by connecting a chemically selective layer (the recognition element) to an electrochemical transducer. An optical sensor is a device that transforms light beams into electrical impulses. It measures the physical quantity of light and then converts it into a readable form using a device.

An optical sensor is often part of a larger system that includes a light source and a measurement device. In recent years, bio-point-of-care biosensors have taken place in both laboratory and commercial applications to detecting hazardous contaminations such as bacteria, mycotoxin, heavy metal ions, etc.

Bio-Point-of-Care (BPOC) Biosensors

BPOC is a sensing element that is initially coupled to a detection element. The detection element is connected by a transducer which converted its changes into an intelligible signal. The substrate used in BPOC biosensors is decided based on their availability, flexibility, biodegradability, biocompatibility, and permeability.

Some common substrates such as paper, polydimethylsiloxane (PDMS), and silicone have been used. Among them, the use of paper as a substrate is very popular, due to its fibrous structure, enabling us to easily modify it. Moreover, the paper has a capillary nature, making the liquid sample flow easily on the substrate, while also providing the possibility of the penetration of gaseous samples into its textures (Gong and Sinton, 2017).

Most paper-based sensors have recently been made of cellulose substrates. Cellulose papers have a specific surface area of 1.4 m^2/g. The porosity of the papers is high. It has good hydrophilic properties, mechanical strength, and is easily degradable. Compared to other cellulose substrates, bacterial cellulose has specific advantages, such as renewability and biocompatibility. The paper porosity increases up to 92% (Bordbar *et al.,* 2021). Glossy paper is another substrate used to prepare paper sensors.

This type of paper is made of cellulosic fibers bonded to inorganic material, giving rise to flexible, nondegradable, and relatively smooth substrates, whose surface can be easily modified with other compounds, such as nanomaterials (Kuhl *et al.,* 2011).

Application of Paper-Based Biosensors

Paper-based biosensors can be used in the detection of metal ions, bacteria, mycotoxins, and Organophosphates explained below.

1. Heavy metal ions detection: The metal ions can enter into the environment from different sources such as fertilizers, pesticides, fuels, and pollutants from vehicles and food, and other industries. These metal ions reduce the quality of air, water, and soil. When the human body is exposed to heavy metal ions, they disrupt the body's immune system, resulting in respiratory, skin, digestive, kidney, and liver problems and even cancer, in acute cases.

According to World Health Organization (WHO) guidelines, the acceptable limit of heavy metals in aqueous samples should be in the range of 0.010.05 mg L^{-1}. (Sall *et al.,* 2020). Numerous paper sensors have been designed to detect Cu ions, based on colorimetric, fluorometric, and electrochemical methods. Similarly, paper-based sensors are also available for the detection of lead, chromium, cobalt, mercury, etc. however, they can be designed for other detection of other heavy metal ions like cadmium, fluorescence, etc.

2. Mycotoxin's detection: Mycotoxins are secondary metabolites produced by fungi, such as Fusarium, Aspergillus, and Penicillium, when harvested or stored improperly. These fungi can be found in agricultural products, such as wheat, peanuts, bran, sesame seeds, peppers, and a variety of spices.

These toxins can enter the human body either directly (through polluted agricultural materials) or indirectly (by animal products), causing cancer in tissues as well as gene, liver, and kidney damage. To prevent these problems, the presence of different types of mycotoxins should be detected.

3. Pathogen bacteria detection: Pathogenic bacteria may lead to infections in the human body or even death. The bacteria can infect the lungs, kidneys, stomach, blood, and skin and they can develop from water, food, or air. Annually, two million people are killed by waterborne pathogens alone (Bordbar *et al.,* 2021).

The most common clinical methods used to detect bacterial infections are as follows: culturing, enzyme-linked immunosorbent assay, and polymerase chain reaction. While the accuracy and sensitivity of these methods are very good, however, the diagnosis of infectious diseases in a short time is of great importance. For this reason, many efforts have been made to develop rapid test sensors, a considerable part of which are based on paper biosensors.

A sensor is highly efficient when it can detect fewer bacteria in the shortest possible time. The use of paper biosensors has been reported in the study of food spoilage like cold cuts, sausages, beef, and pork, beverages (orange juice, milk, and drinking water), vegetables and fruits, and biological samples (Ali *et al.,* 2017; Han *et al.,* 2017; Bordbar *et al.,* 2021).

4. Organophosphate's detection: Organophosphate is a type of pesticide, which has a long half-life and accumulates in the environment for a certain period. in organophosphate biosensors, most enzymes are used as bioreceptors, involving the mechanism of enzyme activity inhibition by organophosphate in the body.

In this mechanism, acetylcholine is initially hydrolyzed to choline in the presence of acetylcholinesterase. The resultant product can react with the detection element (being made of gold or silver nanoparticles) used in the sensor structure, thus changing its color.

In another mechanism, the choline produced in the presence of choline oxidase is oxidized to H2O2, followed by its participation in the oxidation reaction with a redox organic substance that changes the oxidized state of the colored substrate to a reduced form, resulting in a change in its color.

Conclusion

Due to their simplicity, low cost, easy fabrication, ease of use, reliable performance, and high ability to detect the analyte paper-based biosensors have been welcomed by a large number of researchers. These types of sensors are commercially available and are used by food, medical, pharmaceutical, and forensics centers, as well as by the environment and the general public to detect hazardous contaminations.

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Supercritical Fluid Extraction

Article ID: 12066

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Summary
Bioactive compounds of plant origin have been defined as natural chemical compounds present in small amounts in plants. Various new extraction methods and conventional extraction methods have been developed, however, until now, no unique approach has been presented as a benchmark for extracting natural bioactive compounds from plants. Supercritical fluid extraction with CO_2 has been gained attention in extracting natural bioactive compounds from plant-based materials such as herbs, spices, aromatic and medicinal plants.

Introduction
Extraction is one of the approaches used to isolate components from plant-based materials. Bioactive compounds are natural secondary metabolites extracted from various plant parts, such as leaves, stem, roots, seeds, flowers, and fruits, by using several extraction procedures. Demand for these compounds has increased because they are perceived as natural and safe for applications in numerous industries such as cosmetics, food, feed, agriculture, and pharmaceuticals. Bioactive compounds have been found to possess a wide spectrum of health-promoting properties for humans and animals such as antibacterial, antimicrobial, anti-inflammation, anti-aging, and anti-cancer effects.

Bioactive compounds - essential oils, carotenoids, fatty acids, phenolic acids, flavonoids were conventionally extracted by steam distillation, solvent extraction, Soxhlet extraction, pressing method and hydro-distillation, but they exhibit some limitations such as being too time-consuming, using too much organic solvents, losing some volatile compounds, degrading thermolabile compounds, the possibility of leaving toxic solvent residues in the extract, low yield, and low extraction efficiency. Therefore, in recent years, green chemistry methods were developed for extraction purposes to reduce energy and solvent consumption, reduce processing times and replace conventional solvents with eco-friendly substitutes.

Modern approaches such as ultrasound-assisted extraction (UAE), pressurized liquid extraction (PLE), supercritical fluid extraction (SFE), and microwave-assisted extraction (MAE) are currently accessible and environmentally sustainable technologies which will reduce energy consumption, enables the use of solvents substitutes, renewable natural products, and ensure a safe and high-quality extract/product.

Ultrasound-assisted extraction is a mechanical technique based on sound waves, frequencies, and amplitudes that stimulate cell wall disruption and the discharge of cell content. Pressurized liquid extraction is a solid–liquid technique consisting of the application of high pressure and temperature that raises the solvent's boiling point and induces its quick penetration into the sample matrix. However, it is not recommended for heat-sensitive compounds due to the high extraction temperature. Supercritical fluid extraction is an advanced technique for extracting bioactive compounds by employing supercritical fluids as solvent. It has gained much attention over traditional methods due to its significant benefits, such as higher selectivity, diffusivity, and ecology.

Concept of Supercritical Fluids Extraction and Principle
Supercritical fluid extraction (SFE) which is one of the best techniques for removing natural chemical components such as flavonoids, essential oils, seed oils, carotenoids, and fatty acids from natural plant materials. Basically, a simple SFE process comprises extraction and separation as the essential steps. During extraction, either solid or liquid samples may be used, depending to the system settings, but solid samples are more used compared to liquid samples. Regarding solid samples, columns are filled with pre-treated (dried and milled) samples and the pressurized supercritical solvents flow through the column and dissolve extractable compounds from the solid matrix. The dissolved compounds are transported by diffusion out to the separator where the mixtures of extract and solvent are separated through pressure reduction, temperature increase, or both.

The most simple system consists mainly of a chiller used to cool the solvent gas, a solvent pump that pushes the fluid throughout the system, an extraction column that holds the samples to be extracted, separators which collect the extract, heat exchangers for adjusting the temperature of process materials, an oven utilized to keep the extraction column above the critical temperature of the extraction fluid and a back pressure regulator used to maintain the pressure in the system above the critical pressure of the fluid. SFE can be implemented in two different modes: dynamic and static which can be used separately or combined during extraction. In dynamic mode, the supercritical fluid flows steadily through the extraction column containing the sample, while in static mode, the sample absorbs the supercritical fluid and there is no run-off fluid from the extraction column during the process.

Use of Carbon Dioxide in Bioactive Compound Extraction

Carbon dioxide is extensively used as the supercritical fluid in various fields for extraction purposes due to its critical properties (Tc = 31.1 °C; Pc = 73.8 bar), it is chemically inactive, economical, high diffusivity, reusable, inert, easily accessible, separable from extracts, non-toxic, non-flammable, non-corrosive and is an approved food-grade solvent which makes it an excellent solvent for extracting bioactive compounds sensitive to heat. The unique solvent properties of supercritical carbon dioxide have made it a desirable compound for separating antioxidants, pigments, flavors, fragrances, fatty acids, and essential oils from plant and animal materials. It is a cheap and readily available in large quantities with a high degree of purity, furthermore it is an environmentally friendly substitute for organic solvents and is designated as a safe solvent by different organizations such as the U.S. Food and Drug Administration (FDA) and the European Food Safety Authority (EFSA).

A further advantage of SC-CO_2 is its ability to produce extracts free of solvent residue because CO_2 is a gas at ambient temperature and pressure, so it can use a low amount of solvent and minimize thermal damage to bioactive compounds due to its low critical temperature. To obtain the targeted compounds, a polar co-solvent such as methanol, ethanol, and water is generally used to enhance the dissolvability of polar compounds in the supercritical mixture and improve the selectivity of SC-CO_2.

Parameters to Consider during SFE

1. Temperature and pressure.
2. Co-solvent/modifier.
3. Raw matrix on SFE.
4. Extraction time.

Applications of Super Critical Fluid Extraction

1. Food industry.
2. Pharmaceuticals industry.
3. Cosmetics industry.

Conclusions

The interest in supercritical fluid extraction is not only at the laboratory level as an analytical tool but also in industrial processing, mainly decaffeination of coffee or tea, extraction of essential oils, extraction of high added value compounds and fatty acids. Supercritical fluid extraction is favored due to its high selectivity, high efficiency, and short extraction time. This technology will experience continued growth in the coming years and will be beneficial to sustainable development, given its green credentials, and will help to reduce the use of organic chemicals.

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Entrepreneurial Opportunities in Small Ruminant Production

Article ID: 12067

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Entrepreneurship-Concept

The term 'entrepreneurship' in its simplest form refers to a process by which individuals launch and manage their own business and industrial enterprises. Various scholars, over the years, while defining the concept laid emphasis on a wide spectrum of activities which include:

1. Self-employment of any sort.
2. Creation of organizations.
3. Innovation applied to a business context.
4. The combination of resources.
5. Identification and exploitation of opportunities within the economic system or market.
6. Bringing together of factors of production under uncertainty.

Entrepreneurship Opportunities in Small Ruminant Sector

small ruminant sector is an ideal livelihood option for the underprivileged rural households. Nevertheless, the sector remains under-exploited and offers a wide range of entrepreneurial opportunities some of which are:

1. Meat production: The country has a huge demand of meat production with preference to sheep/goat meat in many regions of the country. As such setting up of entrepreneurial units of sheep and goat for meat production can offer tremendous opportunities for income generation.

a. Case study-1: A study was conducted on economics of sheep farming in northern Himalayan region of India. The study was conducted in field conditions. The results have been presented in table-I.

Table-I: Tentative estimate of expenditure and income components in sheep rearing (mutton as main product)

Category	Variant	A*	B	C
Housing costs (Rs)	Construction costs	13792	15959	20588.08
	Depreciation (A)	689.61 (0.92)	797.97 (0.52)	1029.40 (0.35)
Cost of animals (Rs)	Cost of animals	146742	274366.86	521944.44
	Depreciation (B)	11012.5 (14.67)	20605.92 (13.47)	39238.89 (13.46)
Recurring cost (Rs)	Concentrate (c)	20599 (27.43)	49925.68 (32.62)	87983.33 (30.18)
	Dry fodder (D)	34327 (45.72)	68406.81 (44.70)	135260 (46.40)
	Labour (E)	6213.24 (8.28)	9117.16 (5.96)	21775 (7.47)
	Miscellaneous (F)	2242.28 (2.99)	4178.70 (2.73)	6193.88 (2.12))
Total cost (Rs)	(X=A+B+C+D+E+F)	75083.63	153032.24	291480.5
Income (Rs)	Sale of lambs (G)	83111.36 (76.22)	166052.66 (75.40)	361419.17 (77.91)
	Sale of culled stock (H)	15919.12 (14.60)	17130.18 (7.78)	32500 (7.01)
	Sale of wool (I)	3708.65	6656.19	13876.24

		(3.40)	(3.02)	(2.99)
	Value of additional lambs retained (J)	6297.81 (5.78)	30396.07 (13.80)	56110.14 (12.10)
Gross income (Rs)	(Y=G+H+I+J)	109036.94	220235.10	463905.55
Net income (Y-X)/year		33953.31	67202.86	172425.05
Net income/Year/animal		1787.01	1920.08	2652.69
Net income/month		2829.44	5600.23	14368.75
Benefit: cost ratio		0.45	0.44	0.59

(Source: shah *et al.*, 2017)

****A=sheep units with a flock size of 0-30 (average 19 ewes+0 rams), B= sheep units with a flocksize of 30-60 (average 34 ewes+1 rams, C= sheep units with a flock size of > 60 (average 63ewes+2 rams). Figures in parenthesis under costs and income are percentages w.r.t gross expenditure & gross income, respectively.***

b. Case study-II: A study was conducted on economics of goat farming under traditional low input production system in Uttar Pradesh. The results have been presented in table-III:

Table II: Category wise economics (Rs) of different flock sizes:

Category /Annual expenditure	Small	Medium	Semi-medium	Large	Average
Average flock sizes (Nos.)	9.30	20.60	36.80	77.80	36.20
Value of initial stock	13,869	26,614	47,412	1,14,906	37,879
Investment on feeding	3,450	5,280	6,120	12,280	6,783
Depreciation on shed	1,333	2,247	2,247	4,023	2,310
Veterinary aids	490	767	2235	1773	1005
Total variable cost (I to iii)	5273	8294	12040	18076	10098
Gross expenditure	19142	34908	59452	132982	47977
Value of existing stock	16825	28745	48522	124206	41412
Sale of goats*	8910	17880	28060	45620	25118
Sale of milk	4760	9542	14960	24331	13398
Sale of manure	1180	2398	3750	6084	3353
Annual return (i to iii)	14,850	29,820	46,770	76,035	41,869
Gross income	31,675	58,565	95,292	20,0,241	83,281
Net income	12,553	23,657	35,840	67,330	35,305
Net profit/goat	1,348	1,148	974	865	1,014

(Source: Prasad *et al*., 2013)

***(Sale of goats includes all e.g., kid, buck, doe and spent)**

2. Milk production: Although small ruminants contribute approximately 4% to national milk production, goats offer certain advantages over traditional dairy animals (cattle/buffalo) with regard to both milk and meat production. Firstly, the rearing cost per animal is lower in goats than cattle and buffalo and secondly goat has better ability of goat to thrive in harsh climates and rugged terrains. Goat milk is widely recognized as having high nutritional properties. Goat cheese is globally a premium product. In the global market, demand for goat milk, and milk products like cheese, yoghurt far exceeds supply.

Small entrepreneurial units of goats can be taken up with less capital investment in areas with high milk/meat demands which are unsuitable for other livestock in terms of topography, climate and feed/fodder resources.

3. Wool/ Pashmina production: Wool is another important product obtained from sheep although in most of the cases, meat fetches the main value. However, the country has wide variety of sheep breeds and some of which are suitable for quality wool production. Sheep breeds for northern Himalayan region have relatively fine wool suitable for apparel manufacture. Sheep units of fine wool breeds can be setup in such regions to cater to the demands of wool in other parts of the country. Although wool alone cannot sustain the enterprise but it can increase the overall profitability.

Pashmina, the fibre obtained from Changthangi goats fetches very high value in the market. Although such goats are mostly limited to certain pockets in the Changthang region of Ladakh of Jammu and Kashmir, the demand of pashmina based shawls exists throughout the country. Small entrepreneurial units of pashmina goats can be taken up in the region to cater to the demands of pashmina elsewhere in the country. A changthangi goat produces on an average 200-250 grams of pashmina fibre a year. If it is processed into a shawl, it will cost more than 15000 depending upon the amount/percentage of pashmina and other fibres. Further, with embroidery the shawl will fetch even more renumeration. As such, an entrepreneurial unit based on the processing of pashmina fibres into apparels will not only provide a healthy renumeration but at the same time, it can promote the revival of traditional cottage industry by engaging the artisans in the value addition process. The fibre obtained from the animal contains a large quantity of less renumerative guard hairs from which the pashmina fibre has to be sorted. The process of sorting will need labour and thus can further promote employment generation.

4. Shearing units: Shearing is an unavoidable managemental practice pertaining to sheep rearing. On an average each sheep is sheared twice a year. The process is labour intensive and demands expertise. The sheep rearers often have to hire the trained personnel for shearing of their animals. Machine shearing has eased the shearing process and at the same time is very fast in comparison to hand shearing. However, capital investments on the machine, electricity dependence besides lack of expertise often discourages ordinary farmers towards maintaining their own machines. This leaves ample scope for entrepreneurship in this area. A trained person can on an average shear 80-100 animals a day.

Table: III: Tentative cost: benefit analysis of shearing units:

Particulars	Animals shorn	Labour charges (Rs)	Fuel charges (Rs)	Depreciation on equipment	Shearing charges (Rs)	Net income (Rs)
Per day basis	70	1600	400	-	2800	800
Per year basis	4200*	96,000	24,000	5000	168,000	43,000

***Assuming 30 days of shearing in one season with two shearings a year at a shearing cost of Rs 40/ animal. Cost of portable shearing equipment Rs 50,000 with 10 % annual depreciation.**

Conclusion

Small ruminant production presents ample opportunities for entrepreneurship in terms of the diversity of the obtained products coupled with their ever-increasing demands. Such entrepreneurial units can be set up at very low initial investments and can serve as a good source of employment. Value addition process of the obtained products can further provide sustenance to many skilled people associated with the sector.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

International Water Management Institutions for Enhancing Water and Food Security

Article ID: 12068

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Introduction

Water resources and their management are becoming crucial as the water demand is increasing in all the sectors to unsustainable levels with demand in the agriculture sector being the largest. India has a vast population and therefore there is a huge demand for food. The variability in the availability of water poses a significant threat not only for water security but also for farmers due to their access and distribution of water. This article examines the performance of water management institutions through a framework, which relates their structures, processes, and governance features to their performance on stated objectives.

International Water Management Institutions

1. International Water Management Institute (IWMI), Colombo, Sri Lanka.
2. International Center for Water Technology (ICWT), California State University, Fresno.

International Water Management Institute (IWMI), Colombo, Sri Lanka

Introduction:

a. he International Water Management Institute (IWMI) is a non-profit international water management research organization under the CGIAR with its headquarters in Colombo, Sri Lanka, and offices across Africa and Asia. Research at the Institute focuses on improving how water and land resources are managed, to underpin food security and reduce poverty while safeguarding the environment.

b. IWMI is a research-for-development (R4D) organization, with offices in 13 countries and a global network of scientists operating in more than 30 countries.

c. IWMI's Vision reflected in its Strategy 2019-2023, is 'a water-secure world'. IWMI targets water and land management challenges faced by poor communities in developing countries, and through this contributes towards the achievement of the Sustainable Development Goals (SDGs) of reducing poverty and hunger and maintaining a sustainable environment.

d. IWMI is a member of CGIAR, a global research partnership that unites organizations engaged in research for sustainable development, and leads the CGIAR Research Program on Water, Land and Ecosystems. IWMI is also a partner in the CGIAR Research Programs on: Aquatic Agricultural Systems (AAS); Climate Change, Agriculture and Food Security (CCAFS); Dryland Systems; and Integrated Systems for the Humid Tropics.

e. In 2012, IWMI was awarded the prestigious Stockholm Water Prize Laureate by Stockholm International Water Institute for its pioneering research, which has helped to improve agricultural water management, enhance food security, protect environmental health and alleviate poverty in developing countries.

IWMI's Mission: To provide evidence-based solutions to sustainably manage water and land resources for food security, people's livelihoods and the environment.

IWMI's Vision: Water for a food-secure world

IWMI's Strategic Objectives:

a. Food for people: Create and accelerate sustainable increases in productivity and production of healthy food by and for the poor.

b. Environment for people: Conserve, enhance and sustainably use natural resources and biodiversity to improve the livelihoods of the poor in response to climate change and other factors.

c. **Policies for people:** Promote policy and institutional change that will stimulate agricultural growth and equity to benefit the poor, especially rural women and other disadvantaged groups.

The Challenges for IMWI:

a. Water scarcity- This is a critical issue for many countries in the developed and developing world.
b. World Food Crisis in 2008- Food prices rose by over 40% in less than 12 months.
c. In Africa and Asia, many poor people live on $1 per day or less.
d. The need for research has never been greater.

IWMI's Guiding Principles:

a. A focus on poverty and gender.
b. Improving and safeguarding water access as a pathway to poverty reduction.
c. Integrated Water Resources Management (IWRM).
d. Understanding the interaction of agriculture with other ecosystems.
e. Evidence-based water policy and management.

IWMI's Strategic Advantages:

a. Offices in 12 countries in Africa and Asia.
b. A problem solving/adaptive management focus aimed at putting research into development action.
c. A culturally appropriate and gender-equitable approach targeted for different operating environments.
d. A focus on capacity building of developing country nationals.
e. A knowledge and evidence-based approach to problem-solving.
f. An integrated water resources management and multi-inter disciplinary approach.

International Center for Water Technology (ICWT), California State University, Fresno

Introduction:

a. The International Center for Water Technology (ICWT) was established to provide education and research to assist in developing and adopting innovative solutions and technologies that improve water use efficiency. The program's broad mandate includes water supply and quality; flood protection; and environmental enhancement. Activities focus on extended education, laboratory and field research, and policy development.
b. The International Center for Water Technology is a public-private partnership dedicated to the development and application of advanced technologies that enhance water use for agricultural, environmental, and urban purposes. California State University, Fresno – in collaboration with a consortium of members in the water technology industry – came together to form ICWT.
c. Through applied technology, our goal is to provide efficient first use and effective reuse of water supplies worldwide
d. Water is a finite resource. Responsible management requires the inclusion of all stakeholders to determine appropriate long-term use and allocation. While the program targets opportunities and issues within the San Joaquin Valley region, solutions and experiences are applicable worldwide.

Why ICWT Makes Good Business Sense: Whether your company is a "start-up" venture with a new idea or an established manufacturer with proven technology, ICWT has something for everyone. ICWT can assist you with a wide range of professional services, including business plans; workforce development; research & development; and export marketing, to name just a few. One-on-one assessments are available to discuss which programs best fit your needs.

ICWT Services: In addition to providing a world-class, year-round water technology demonstration facility, ICWT will advance water and fluid science technologies worldwide through four major activities:

a. Business Development Assistance:

i. Business planning.
ii. International trade.
iii. Idea-sharing venues.
iv. Identifying funding sources.

b. Research and Development:

i. Laboratory testing, evaluation and product development.
ii. Field and applied product testing.
iii. Partnerships to identify "Water Smart" technologies.

iv. Water treatment demonstrations.
v. Renewable energy water pumping.

c. Industry Testing and Certification:

i. Hydraulic testing of valves and fittings- head loss.
ii. Certified water quality testing services- urban, environmental, and agricultural water supplies.
iii. Independent performance certification including pumps, water meters, backflow devices.

d. Technology Development Assistance:

i. Business planning assistance.
ii. International trade assistance.
iii. Idea-sharing venues.
iv. Identifying funding sources.

Conclusion

Water management institutions focus on water availability and access, including adaptation to climate change; how water is used and it can be used more productively; water quality and its relationship to health and environment; and how societies govern their resources.

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Nematodes as Bioindicators

Article ID: 12069

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Summary

Nematodes are the abundant metazoa which vary in their sensitivity to pollutants and environmental disturbance. Soil nematode communities are useful biological indicators of soil health due to their community characteristics like abundance, diversity, community structure and metabolic footprint all of which are closely correlated with the soil environment. The community size, complexity and structure reflect the condition of the soil. Both free living and plant parasitic nematodes are effective ecological indicators, contributing to nutrient cycling and having important roles as primary, secondary and tertiary consumers in food webs. Crop management practices may have strong effects on soil nematodes, that change the soil nematode communities. Some free-living nematodes function as biological models to check soil condition within the laboratory. Owing to the above advantages, soil nematodes are being used as biological indicators of soil health.

Introduction

Biological indicators include protozoa and metazoa. Nematodes, the foremost abundant sort of metazoan (Bongers and Bongers, 1998), vary in terms of their sensitivity to pollutants and environmental disturbances, and therefore the nematode communities are widely accepted as simple indicators of soil quality and soil health. Soil nematode (free-living and plant-parasitic) are correlated with the extent of nitrogen cycling and decomposition (Neher, 2001). Free-living nematodes reflect the biodiversity of soil ecosystems and soil health.

Nematodes as Biological Indicators

Since bacteria, fungi and nematodes are the dominant component of microbial biomass, they are often considered that they supply the simplest indication of soil's biological status. Their life cycles are relatively short (hours or days), which lead to rapid population change rapidly in response to changes in environmental conditions.

There are variety of reasons why nematodes are commonly used as biological indicators, since, they occur in millions in every square meter of soil and are readily extracted from the soil and they prey on plant roots and on the organisms that live in the soil as well. (e.g., bacteria, fungi, algae, diatoms, protozoans, rotifers, tardigrades, springtails, arthropods, oligochaetes and nematodes). Nematode numbers fluctuate in response to the population dynamics of the organisms they consume, and also are influenced by the soil physical and chemical environment.

Ecological and Functional Characteristics of Nematodes Determined as Indicators

Soil nematodes are divided by feeding habit into bacterivores, fungivores, herbivores, omnivores and predators. Most soil nematodes are bacterivores and fungivores which prey on bacteria and fungi. Changes in bacterivores and fungivores may reflect changes in decomposition pathways (Schratzberger *et al.,* 2019). Free-living nematodes (beneficial nematodes), which constitute 60 to 80 % of all soil nematodes, include bacterivores, fungivores, omnivores and predators. All engage in nutrient cycling and energy transfer within the soil food cycle, enhancing the soil ecology. Increased microbial activity may enhance the numbers of bacterivore nematodes, but acidification or metal-induced stress may decrease bacterivores and increase fungivore numbers.

Herbivore's nematodes cause damage value at over 80 billion USD annually. The most damaging nematodes are root knot (*Meloidogyne* spp.) and cyst nematodes (*Heterodera* and *Globodera* spp.) (Jones *et al.,* 2013). Using nematicides to regulate herbivores is an efficient measure but it decreases the population, diversity and maturity of fungivores and bacterivores at an equivalent time (Grabau and Chen, 2016). Omnivores and predators represent the smaller proportion of soil nematodes, feeding on bacteria, fungi, protist and nematodes. They are sensitive to environmental disturbance and their densities in undisturbed soils are more than in disturbed soils (Ferris and Bongers, 2006). Increasing N fertilization may reduce the relative abundance of omnivores and predators in agriculture fields (Song, 2015).

Soil Nematode Community and Variety Indicators

Continuous strawberry cropping reduces nematode diversity, the predominant decomposition pathway changing from bacterial to fungal as NCR decreases, while plant feeder abundance increases significantly, showing that the soil could also be harmful to plant growth under continuous cropping (Li *et al.,* 2016). When banana is rotated with papaya, pineapple or rice, the abundance and functional metabolic footprint of bacterivores, fungivores and omnivore-carnivores were found to increase (Zhong*et al.,* 2016). Maize-soybean rotation is an agricultural practice during which soybean cyst nematode, *Heterodera glycines*, is effectively controlled (Hu *et al*., 2018).

Root exudates act as olfactory compounds and soil chemokines as taste compounds and are nematode attractants across different nematode taxa and feeding guilds (Dong *et al*., 2014). Adding nutrients (chemical/organic) directly influenced the soil nematode community, thus changes in soil nematodes reflect the consequences of nutrient applications on soil health (Zhao *et al*., 2014). Nitrogen fertilization increased total nematode abundance but decreased nematode generic richness. Increasing N fertilization resulted in minor changes in bacterivores but decreased the abundance of omnivores and predators, and fungivores were suppressed by high N fertilization (300 kg$ha–1 $yr–1 N) (Song *et al*., 2015). In tropical secondary forests (P-poor soils), additions of P suppress the density of total nematodes and omnivore-predators and degrade the trophic links of the soil food web. Application of organic like manure increases the nematode functional metabolic footprints. Plant-parasitic nematodes got controlled by adding organic amendments. Soil nematodes reflect the results of anthropogenic interventions (environmental pollution and agricultural activities) and therefore the principal features of natural biocenoses (vegetation type, geographic location and climatic conditions) (Matveeva and Sushchuk, 2016). The nematode community indices therefore allow useful assessment of soil health.

Caenorhabditis elegans - to Gauge Soil Health

Soil nematode data often won't assess soil condition for instance, many laboratories use free-living nematodes (principally *C. elegans*) for preliminary assessment of soil condition (Tejeda-Benitez and Olivero-Verbel, 2016).

The benefits of *C.elegans* are:
1. Brief lifespan,
2. Simple and cheap cultivation (300–350 eggs per nematode),
3. Availability of entire genome sequence and lots of genetically modified strains,
4. Rapid response to environmental change (Bouyanfif *et al*., 2019).

Kim *et al*. (2015) used an offspring counting assay as a bioassay for soil ecotoxicity evaluation to gauge the chemical toxicity of several metals. The toxicity trend for every metal was classified consistent with the number of offspring. Cation exchange capacity, water holding capacity, clay and silt fractions reduced the numbers of offspring, whereas the electrical conductivity and sand fractions increased their numbers. Physical, chemical and biological parameters affect the reproduction and movement of free-living nematodes like *C. elegans*, and these organisms are often used for the preliminary evaluation of soil condition.

Future Perspectives

Nematode community structure reflects soil condition. Evaluating soil quality reflects changes in the diversity and structure of soil nematode community. Unhealthy soils are the result of excessive use of chemical fertilizers and pesticides, especially in long-term monocropping systems. Moreover, soils are increasingly subject to degradation, pollution, deterioration in their physicochemical properties, which reduce the biodiversity and low productivity of soil nematodes. These organisms are involved in nutrient cycling, energy transfer and global soil carbon cycling. Increasing bacterivore and fungivore abundance may enhance the decomposition of soil deleterious organisms and reduce their impacts in the trophic structure. Lowering herbivore abundance can promote plant growth. Thus, classifying soil nematodes using molecular approaches will increase the accuracy rate of them. Thus, utilization of soil nematodes for soil health assessment with optimized approaches will extend crop productivity and nutritional quality while decrease nematode disease in harvested products as well.

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E-ISSN: 2581 - 8317

Brief View of Modernisation in Agriculture: A Solution Towards Farmer's Problems

Article ID: 12070

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Introduction

Traditional Agriculture is an old concept which is practised by farmers from ancient times. It generally involves use of indigenous knowledge, natural resources, cultural beliefs of the farmers. As we are crossing the years are, there is tremendous change in the rainfall pattern, change in the climate, drought existence which made farming system to face difficulty in production. So, by considering the facts, slowly traditional agricultural activities shifted to technology-based activities which is process of Modernisation in Agriculture. It includes use of hybrid seeds instead of self-retained seeds by farmers, optimum use of fertilisers, machinery, mobile apps for climate information etc. which helps in improvement of crop yield.

Driving Factors to Fasten the Modernised Agriculture

1. Improving use of Mobile technology by the farmers: Every farmer should become aware of use of mobile which gives information about sowing dates of crops, monsoon arrival, weather forecasting the farmer also have accessibility to know the prices of crops in the market. The mobile technology can also detect the moisture sensors in the ground which gives idea about the level of moisture present at certain depths in the soil. Ex: Farm-o-pedia, Bhuvan Hailstorm App, MK isan Application, Agri Market.

2. Unmanned aerial vehicle in agriculture: It is usually called as Drone. A small airplane which can move across the field and monitors, captures the pictures of crops. It also helps us in pesticides, fertilisers spraying across the field. Ex: DJI Air 2S, Ryze Tello, DJI Phantom 4 Pro V2.

3. Efficient water management: More irrigation to crops leads to lodging and less irrigation makes crops to wither away. Optimum irrigation is required. Sprinkler or drip irrigation helps farmers to use the water resources very efficiently. State governments also giving subsidies on purchase of equipment. Ex: Farm ponds in dry land areas, Dig pits for storing water, drip irrigation, Collection pits

4. Use of Machinery instead of labour force: It saves lots of labour hours through right equipment like seed drill, tractors, ploughing machines. It decreases the labour cost and also fasten the field works. Ex: Automatic row weeder, crop harvesters, Cow milking machines.

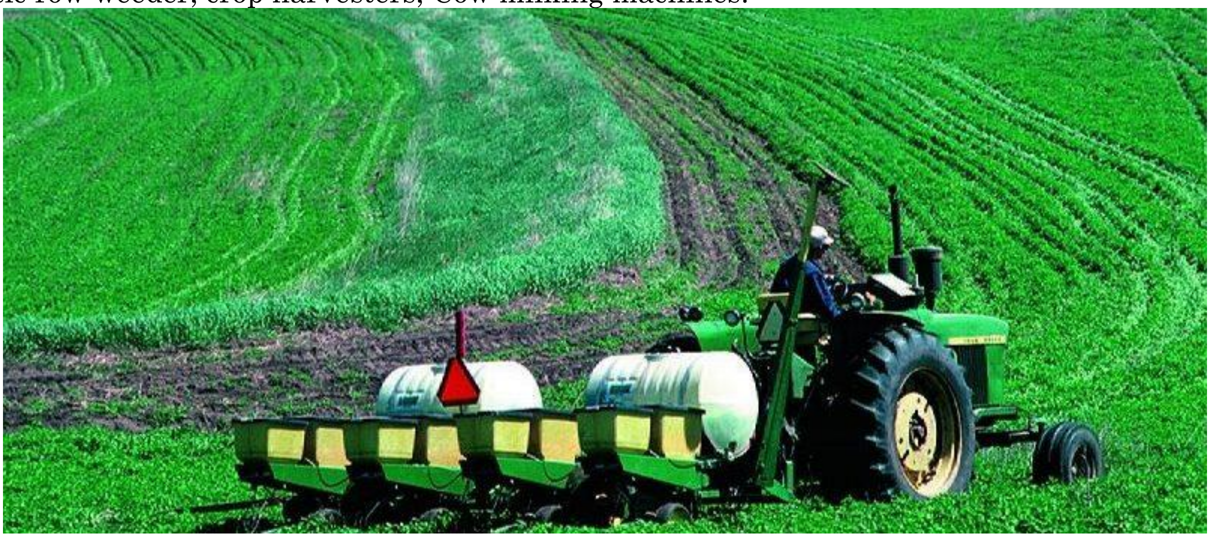

Figure 1: Source: http://willowmoonfarm.com/modern ways of farming

5. Research and Development: The concept has started with green revolution by using of high yielding varieties of Rice and wheat. SAU, ICAR, Agricultural institutions have annually developed number of hybrid varieties which will be suitable and can grow during adverse climate conditions. Farmers should always interact with their local scientists to improve their crop yield performance.

6. Set up of fertiliser manufacturing industries: The crop yield always depends upon the nutrient availability to it. Every farmer uses the fertilisers for growth of the crops. Large set up of manufacturing industries is much more needed so that it will be available to farmers in good quality and at reliable price. Ex: Mangalore Chemicals & Fertilizers Ltd, Coromandel International Limited.

7. Use of electronic media for marketing: Farmer should be aware of electronic trading for Selling of his crop produce to the consumer. It avoids middle men and will give high share of profit to producer as it reduces the exploitative intermediaries. Ex: E-NAM, Commodity exchanges.

Modernise Agriculture and Sustainable Agriculture

Sustainable agricultural practices protect the environment and improve the natural resource. Three main goals are environmental health, economic profitability, and social equity. It includes the practices like; organic farming, crop rotation, mulching, conservative agriculture etc. New technology, irrigation managements, fertiliser manufacturing industries may have chances to effect sustainable agriculture in a negative manner Modernisation of agriculture should not be threat to degradation of natural environmental. It should involve the principles of sustainable agriculture.

Conclusion

It is difficult to choose between modernise agriculture and sustainable agriculture. By considering the circumstances like adverse climate effects, farmer have to be smart enough to choose artificial intelligence technology. To reduce soil erosion, increase soil fertility, farmer has to choose sustainable agricultural practices. Through several reports, it is noticed that, a greater chance is going towards evolution of modern technology.

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WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Role of Biochar in Organic Farming

Article ID: 12071

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What is Biochar?

Soil is the most essential source of nutrients and a home for numerous microbes. Due to the rapid depletion of agricultural areas and soil quality as a result of ever-increasing population and the overuse of chemical fertilisers, a rehabilitative strategy to agricultural crop production is urgently required. Biochar is a solid, carbon-rich substance created from the pyrolysis of various biomasses. Biochar is a form of charcoal made by heating organic materials (plant or animal waste) to temperatures above 250°C in a low-oxygen atmosphere (this process is called pyrolysis). This technique yields a single carbon product with a stable structure and inert properties. Biochar reduces carbon dioxide (CO_2) emitted into the atmosphere because pyrolysis captures the carbon in the biochar, which would otherwise be emitted through decomposition or the burning of crop residue. Biochar is undeniably more durable than any other form of organic matter in soil; it can last hundreds to thousands of years in the soil.

Why the Importance for Biochar in Agriculture?

Biochar was first used to modify soil thousands of years ago in the Amazon basin, where locals mixed kitchen ash and charcoal to create islands of fertile soil known as terra preta. Biochar helps increase sustainable crop production in locations with severely degraded soils, scarce biological resources, and insufficient water by preventing soil erosion. Carbon dioxide levels in the atmosphere are rising as a result of the burning of fossil fuels and the breakdown of biomass. Adding biochar to these soils, on the other hand, can assist reduce carbon dioxide emissions because biochar can hold 50% of the carbon. Biochar is highly stable and it controls the emission of carbon dioxide from organic decomposition to a great extent and it also plays an important role in controlling the emission of methane and nitrogen dioxide from the soil.

Use of Biochar in Agriculture

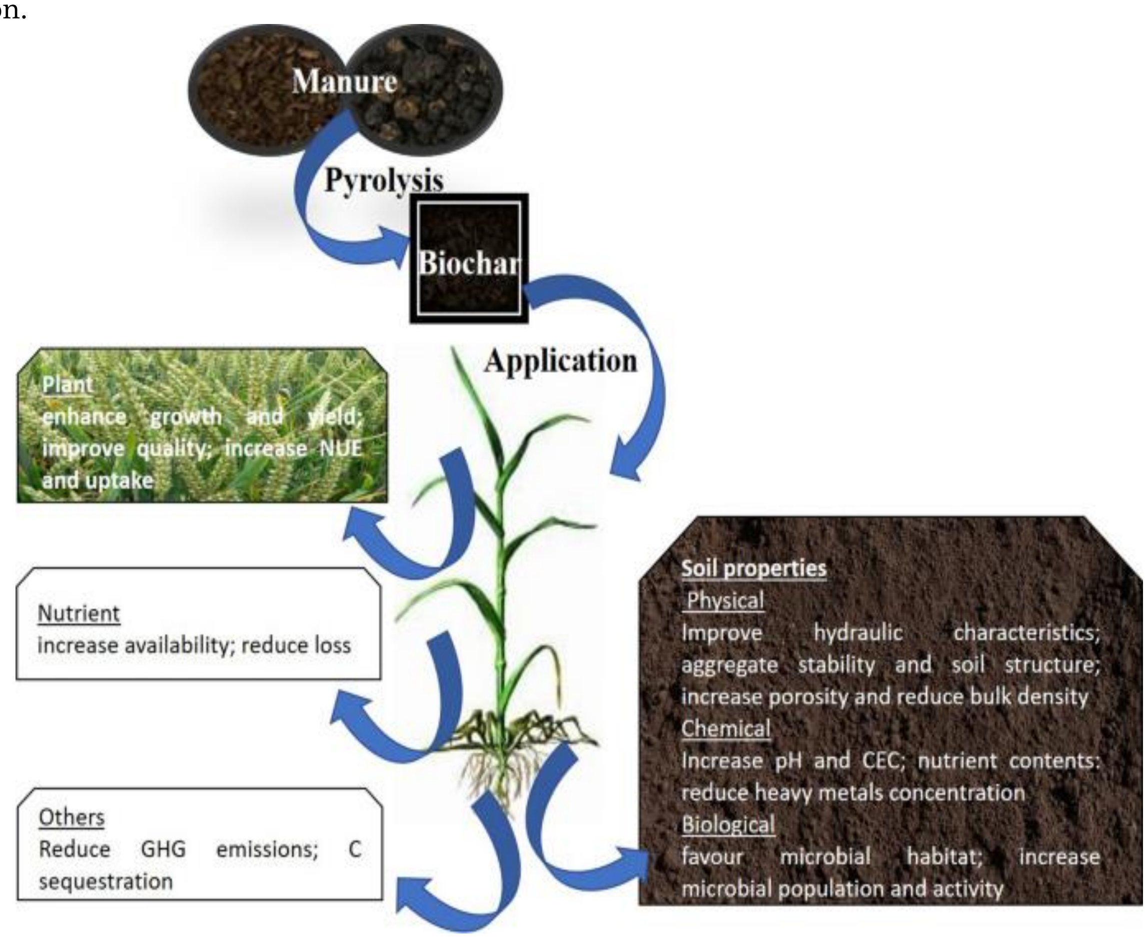
1. Biochar increases soil fertility and crop yield.
2. Increases the retention of nutrients in the soil.
3. Reducing leaching of nitrogen in groundwater
4. Improves soil structure and enhances water holding capacity.
5. Regulates soil acidity.

6. Provides a safe habitat for microorganisms and fungi.
7. Reducing carbon emissions to control climate change.
8. Biochar reduces carbon dioxide (CO_2) and nitrous oxide (NO_2) emissions from the soil by 50-80%. NO_2 is an important greenhouse gas, 310 times more potent than CO_2.
9. Biochar's vast surface area and complex pore structure (surface area of more than 1000 square yards in a gram) provide a safe habitat for microorganisms and fungi.

The Rate and Method of Biochar Application to the Soil

Any soil amendment application rate should be based on extensive field testing, soil type, and crop type. Apply 5-50 tonnes of biochar (0.5 - 5 kg/m^2) per acre combined with nitrogen control to improve crop yield. A single application of biochar has favourable effects for several seasons due to the repeated breakdown in the soil. As a result, unlike manure and synthetic fertilizers, biochar does not need to be added to each crop.

Because of the small particles of biochar, it is important to infuse biochar in ways that minimize losses due to wind or water erosion. Some of the best management practices to avoid these losses are listed below:
1. In suitable weather circumstances, add biochar to the soil while the winds are light. Applying biochar with light rain is also beneficial, as the rain moistens the biochar dust and keeps it on the soil surface until water can be added.
2. Retains moisture in biochar or it can be mixed with moist manure.
3. Use biochar along with other types of amendments such as compost or manure to prepare the biochar formulation.



Conclusion

The problem of agricultural land depletion as a result of the pressures imposed by an ever-increasing population necessitates the adoption of a long-term crop production strategy. It was proposed that biochar be used to remediate contaminated agricultural soil, improve soil fertility by lowering acidity, and increase nutrient availability. Biochar promotes soil fertility, improves soil texture, and increases nutrient availability, all of which reduce fertiliser use and, as a result, fertiliser pollution. Biochar is an excellent way to boost crop productivity and yield. One of the most significant advantages of biochar is that it aids in the fight against climate change by removing carbon dioxide from the atmosphere.

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E-ISSN: 2581 - 8317

An Experience of Low-Cost Integrated Pest Management Practices in Dry lands

Article ID: 12072

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Introduction

In the dry lands of South India, the productivity of crops is low due to several factors like low soil fertility and poor water holding capacity of soil and loss due to pest and disease incidence. The incidence of pests and diseases is due to several factors like mono-cropping in large contiguous area that leads to reduced biodiversity of beneficial organisms, poor organic matter leading to disease outbreak, indiscrimate use of chemical pesticides leading to pest resistance, destruction of natural enemies and outbreak of secondary pests.

Although farmers traditionally had Indigenous Technical Knowledge (ITKs) of using plant extracts for controlling insects, the practices have come down following the introduction of chemical pesticides/insecticides.

Hence, most of the present-day farmers are unaware about the pest/disease management practices on their crops and they often rely on input suppliers for advice and use chemical pesticides which are recommended by them. Integrated pest management is the solution to reduce the usage of chemical pesticides and to utilize the available resources with us. It pays the way for sustainable agriculture also for ecofriendly environment.

Integrated Pest Management (IPM)

Integrated Pest Management (IPM) involves the intelligent combination of different practices to manage the pest below their damage level without harming the ecosystem. Some of the important IPM practices include the use of pest/disease tolerant varieties, cultural practices like deep summer ploughing, seed treatment with biologicals, alternate cropping system involving the use of trap/border/ecofeast crops, continuous monitoring of the crops for pest/disease incidence through Agro Eco-system analysis (AESA), pheromone trap/yellow sticky trap/light trap, mechanical control, use of biological control agents, botanical control and chemical control as a last resort.

Traditional Varieties

Traditional varieties of crops are able to tolerate the attack the pests and diseases, when they are grown using organic manures. Growing resistant/tolerant varieties of crops is one of the options in managing pests and diseases. For example, ICGV 86031, ICGV 2271 varieties are resistant cultivars to groundnut leafminer (*Aproaerema modicella*).

Cultural Practices

Cultural practices like deep summer ploughing help in exposing resting stages of insect pests (pupae) for predatory birds to feed on them. For example, the pupae of red hairy caterpillar (*Amsacta albistriga*) an important pest on groundnut is exposed following deep summer ploughing. Farmers realized that application of neem cake @ 100 kg per ac reduced the attack of root grub (*Lachnosterna serrata, Holotrichia* sp.) on ground nut in Bellary district, Karnataka.

Seed Treatment

Seed treatment with biologicals like *Trichoderma* helps the prevention of seed and soil borne fungal diseases on crops. For example, on groundnut it is used for the control of root rot caused by *Macrophomina phaseolina* and stem rot caused by *Sclerotium rolfsii*. Large numbers of groundnut farmers are using *Trichoderma* as seed treatment @ 4 g per kg of seeds for the control of stem rot.

Seed treatment with biological and biocontrol agents

Cropping System

Cropping system approach helps in reduction in the incidence of pests and diseases due to the unfavourable situation for the multiplication of pests and diseases. Instead of growing a monocrop, farmers adopt a combination of crops keeping in mind the pest management aspects. For example, growing of 3 – 4 rows of bajra on the border of groundnut crop helped in reduction in the spread of peanut bud necrosis disease (PBND) by acting as a barrier for the virus vector, thrips from moving into the field from outside, in Bellary district. Growing of ecofeast crop like cowpea, bajra, niger also helped in the reduction of groundnut leafminer (*Aproaerema modicella*), through the buildup of its natural enemies like parasitic wasps, which fed on pollen, nectar and predatory lady bird beetles which fed on the aphids that builds up on cowpea. Some of the most preferred host plants of pest insects are grown as trap crop to divert the pest from attacking the main crop. Castor grown as border crop for groundnut attracts the dreaded pest Tobacco caterpillar (*Spodoptera litura*) for egg laying as castor is the most preferred host plant thereby the attack on the main crop groundnut is averted.

Crop diversity

Traps

Monitoring of crop pests is of great importance, so as to reduce their attack at the early stage. Various options are used for the monitoring of different type of pests. For example, yellow sticky trap is used for monitoring the major sucking pests like whitefly (*Bemisia tabaci*) and thrips (*Thrips palmi*) on groundnut. When yellow sticky traps are placed at 20 traps per ac, it acts as a management tool against sucking pests. Pest specific pheromone traps at 4 per ac, is used for monitoring the incidence level of caterpillar pests like gram pod borer (*Helicoverpa armigera*) and tobacco caterpillar (*Spodoptera litura*). Light traps @ 1 per 5 ac helps in monitoring the incidence of major caterpillar pests like leaf miner, red hairy caterpillar, Tobacco caterpillar and gram pod borer on groundnut. Farmers in Pudukkottai district of Tamil Nadu used light traps along with bonfire for killing the adult moths of red hairy caterpillar before they laid their eggs on groundnut crop.

Low-cost traps

Mechanical Methods

Mechanical methods of pest management have been traditionally followed by farmers. Farmers of Bijapur district, Karnataka have the practice of dragging the branches of the plant *Euphi agossypina* in the groundnut field to reduce the incidence of leaf miner. The practice helped in the opening of the groundnut leaves folded by the leaf miner larva and exposing it to predators. Hand picking of grownup caterpillars of gram pod borer is a common practice among farmers. Adult beetles of root grub are collected and destroyed by shaking their host trees such as *Acacia,* neem between 7 and 8 pm in and around groundnut field for first three weeks after heavy summer shower.

Bird Perches

Farmers traditionally had the habit of inviting predatory birds to their crop fields for the control of caterpillar pests by broadcasting cooked rice or puffed rice in Bellary district. Birds serve as an important pest reducing agent, their activity is enhanced by avoiding the use of chemical pesticides and erecting 'T' shaped sticks to serve as bird perches.




Parasites and Predators

There are many parasites and predators that are available commercially for the management of caterpillar and sucking pests. The important parasitoid for the management of caterpillar pests is the egg parasitoid *Trichogramma* sp. This parasitoid has to be released @ 50000 per ac per release, coinciding with the peak moth activity observed through pheromone trap catches. The release of parasitoids has to be repeated depending on the incidence of the adult moths.

Biocontrol Agents

Use of microbial biocontrol agent is yet another option available for the management of important caterpillar pests. The pest specific virus, Nuclear Polyhedrosis Virus (NPV) applied @ 100 - 200 larval equivalent (LE) per ac is effective for the control of red hairy caterpillar, Tobacco caterpillar and gram pod borer on groundnut.

Farmers in South India, have the habit of using neem oil, Pongamia oil (*Pongamia pinnata*) leaves of neem, *Vitex negundo* for the control of insect pests. The use of Neem Seed Kernel Extract (NSKE 5%) has superior results over neem leaves or oil and has recently gained popularity among farmers for the management of leafminer and other sucking pests in South India.

Pros and Cons

IPM methods are safe alternative to currently prevailing exclusive chemical methods. They reduce the cost of cultivation and at the same time provide lasting solution for the pest and disease problems. They help in conserving the biodiversity of the ecosystem and prevent contamination of groundwater, soil and farm produce by pesticide residues. The use of IPM helps in better health status of the farm family, livestock and community.

IPM measures needs to be planned well before the start of the season to be effective. The quality and availability of the biological inputs have to be ensured before field application. The biological inputs work under certain favourable situations; hence it is necessary to provide the required conditions for getting the best results. For example, NPV has to be applied along with phagostimulant, UV protectant, wetting agent during late afternoon for the virus to be effective. Similarly, the egg parasitoid has to be released with good protection from rain and predatory insect by placing in a small container covered with nylon net. The lure in the pheromone trap has to be replaced after 20 days. For overcoming the above constraints, thorough knowledge about the practices is essential. Those practices that are more suitable to a given crop or ecosystem has to be chosen from a basket of options. Further early detection is a key element in IPM and this involves knowledge about the various pests and diseases, beneficial organisms, symptoms of damage, threshold level. The level of damage/incidence has to be assessed through AESA and other methods like use of different traps.

Conclusion

Adopting ecofriendly practices and enhancing crop biodiversity has several advantages in terms of soil fertility, pest management, crop yields, costs and returns, and environment. More importantly, it builds farm resilience and makes farmers self-sufficient. Benefited farmers have realized that IPM practices are economical alternatives to chemical pest control. IPM has helped the farmers to move towards ecological agriculture through conservation of biodiversity. Hence IPM as a viable option in addressing the pest/disease management problems of resource poor farmers in dry lands.

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E-ISSN: 2581 - 8317

Karnal Bunt of Wheat

Article ID: 12073

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Introduction

Wheat is affected by various diseases such as rusts, Powdery mildew, loose smut, leaf blight and Karnal bunt. Karnal bunt of wheat is one of the most important and old smut diseases of wheat, it is called partial bunt and their causal organism is *Tilletia indica* or *Neovossia indica* which infects grains at flowering. Mitra (1931) reported the causal organism of Karnal bunt as Tilletia indica but later Mundkur (1940) renamed it as *Neovossia indica*.

The disease was not considered important till 1969-70 but the high incidence of this disease in crop seasons 1974-75, 1975-76 and 1978-79 the consecutive seasons in tarai regions of Uttar Pradesh and Punjab has made it a major of wheat in India. Earlier it was a minor disease found in North-western India and now it has become a potential threat to wheat production in our country. Occurrence of this disease is in many parts of the world such as Pakistan, Nepal, Iraq, Iran, Afghanistan and Mexico.

In India, Karnal bunt is distributed throughout northern parts from West Bengal to western border such as Uttar Pradesh, Haryana, Punjab, Himachal Pradesh, Rajasthan and Madhya Pradesh. It reduces grain quality through the production of masses of powdery spores that discolor the grain, changes the chemical composition of infected grain and makes seed inedible. This disease is easily recognized by fishy smell which taints the grain.

At the beginning of infection, the smut sorus is covered with a membrane (pericarp) which, when it bursts releases black masses of spores that contribute to the bunt smell, the spores may disperse with air or may fall to the ground and thus the inoculum is not limited to only fields but can spread to distant places between boot to anthesis. The disease reduces seed quality, changes the chemical composition of infected grains, and makes seeds inedible and was responsible for an annual loss of productivity which is 40,000 metric tons of grains per year during late sixties. The first report of Karnal bunt from a non-Asian country came from Mexico in 1972, where the disease has been reported from localized areas (500000 hectares) within the state of Somora. The disease was first identified from Karnal and accounts for yield losses of approximately 0.5% annually whereas in susceptible wheat cultivars it suffered losses up to 40%. Karnal bunt play significant economic losses in wheat crop which causes quarantine and other export restrictions on infected ones, whereas, Karnal bunt of wheat poses new threat to human life in united states as regulation deem wheat containing more than 3% bunted kernels unfit for human consumption and these crops are instead used in animals' feed. The infected grains have been given as under:

Symptoms

Karnal bunt is a major fungal disease and causing milling and baking quality deterioration in wheat crop. In infected sample, all kernels of plant head are not affected and due to this reason infected plant are not as readily identifiable. The disease cause reduction in the length of ears and number of spikelets of bunted

E-ISSN: 2581 - 8317

ears. This distribution is the reason for Karnal bunt being referred to as partial bunt. Another factor which makes partial bunt difficult to diagnose in field is that most of infected kernels do not show any symptoms prior to maturity. It produces dark color and fishy smell on infected kernels due to trimethyl amine, this darkening of kernels resulted in kernel tissue being converted in teliospore mass. It also causes "canoe symptoms" as in this process healthy kernel replace into teliospores and the disease tends to hollow out host kernels resulting in canoe shape.

Pathogen

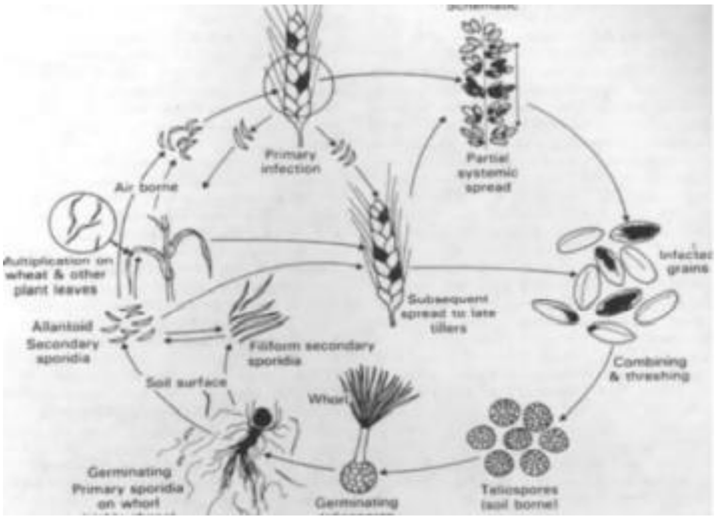
Karnal bunt is named after Karnal, India by Mitra where the disease was first discovered on a wheat crop in 1931. *Neovossia indica* belongs to class Basidiomycetes, order Ustilagiales and family Tillitiacea. This pathogen is seed, soil and air borne. Mycelium of the pathogen is dikaryotic, septate, branched and hyaline. Pathogen produces teliospores which are dark reddish to coppery, dull brown to dark brown and globose to sub-globose with a diameter of 24-47µm and produce two types of sporidia. Two types of sporidia are primary and secondary sporidia which are also known as filiform (for multiplication) and allantoid sporidia (for infection) respectively. Size of primary and secondary sporidia is 64-79×1.5-2µm and 12-13×2µm respectively.

Epidemiology

At flowering stage, wheat is most susceptible to the infection. Favourable conditions for the growth of *Neovossia indica* is cloudy weather with rainfall, 70% relative humidity, (18-24°C) day time temperature while (17-21°C) soil temperature and pH range of 6.0 to 9.5. high dose of nitrogen and close planting also favours the attack of pathogen.

Disease Cycle

Karnal bunt of wheat is air borne disease in which teliospores spread through air and it is also called post-harvest disease. Their fungal spores can remain viable for several years and germinate during favourable conditions. Once spores germinate, they infect wheat flowers and develop large masses of spores on embryo end of the kernel. Teliospores will germinate and produce promycelium. At the apex of promycelium, 65 to 180 primary sporidia are found whereas secondary sporidia can either bud from primary sporidia. These secondary sporidia are responsible for infecting young host plants through ovary wall in flowering stage and accomplished by penetrating in epidermis of host glumes in a gum tube. Sporidia are then able to enter in mature kernels and produce number of teliospores where healthy kernel tissue is used. During harvesting, teliospores fall from the kernels into soil from which they may be carried elsewhere by wind or tools to restart the disease.



Management

Following methods are used to control disease:

1. Cultural Control:

- **a. Resistant varieties:** Use of resistant varieties and resistant cultivars like PBW 502, HD 1907, N75-3, N-75-5, Pastour.
- **b. Crop rotation:** Crop rotation with non-host crops is useful in managing the disease.

c. Mulching: Polyethylene mulching can enable the soil to be disinfected from bunt propagules by increasing the soil temperature to 54.5°C.

d. Irrigation: Controlled irrigation at the time of heading and flowering is useful in controlling the disease incidence.

e. Sowing time: Changing sowing time of wheat can alter flowering to less favorable conditions for infection. f. Fertilization: Avoid use of excessive use of nitrogen fertilizer.

2. Physical Control:

a. Hot water treatment: Hot water treatment of wheat seeds at 52-54°C for 10 minutes before sowing is effective to control incidence of Karnal bunt of wheat as it affects the germination of teliospore without killing the seed. Bleach in combination with heat treatment is also effective (soaking at 35°C for 12 hours).

b. Soil solarization: Soil solarization can reduce the viability of teliospores present in the soil.

3. Chemical Control:

a. Seed treatment: Seed treatment with Chlorothalonil and Carboxin + Thiram @2.5 to 3g/kg of seed can reduce pathogen inoculum.

b. Foliar treatment: Incidence of disease can be reduced by application of Propiconazole, Agrozim and Bavistin between late boot and flowering stage.

c. Soil fumigation: Fumigation of soil with methyl bromide, metham-sodium and formaldehyde can be used for killing teliospores in the soil.

4. Biological Control:

a. Spray of biocontrol agent *(Trichoderma viride)* before ear head emergence followed by spray of Propiconazole at ear head emergence can give almost complete control of disease.

b. Spray with extract of *Azadirachta indica* and *Cassia fistula* is also an effective bio control measure.

Role of Enzymes in Food Processing

Article ID: 12074

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Introduction

Enzyme is an important class of globular proteins of biological origin that act as biochemical catalyst and speed up the rate of biochemical reactions without its consumption in the process. The most distinguishing property of an enzyme in its catalytic action is its specificity and selectivity. Each enzyme catalyses only a specific reaction involving a specific substrate and hence it's great value to chemists and engineers. Another major characteristic of enzyme is its sensitivity to the conditions in which it operates. The enzymes are effective within a specific range of pH, temperature and presence of inhibitors, cofactors, etc. A very useful property of enzymes as catalysts is that they are generally required in very small quantities (Rama Rao, 2002). Enzymes are generally named according to the reaction they carry out. The suffix 'ase' is added to the name of the substrate, i.e., glucose-oxidase, an enzyme which oxidizes glucose.

The enzymes work under more or less mild conditions, making them ideal catalysts to use in food technology, in which the manufacturer wants to modify food raw materials selectively without destroying essential nutrients. In modern food enzyme technology, it is important to realize that these early enzymatic processes were not only fermentations, but also complex and correlate enzyme-mediated processes. The enzymes were remained essential for the provision of fermentation substrates (beer and bread), the development of flavour and aroma (wine) or the creation of the very structure of the product (cheese).

Importance of Enzymes in Food Industry

Now a day, Enzymes are successfully applied in:
1. Increasing the water holding capacity of acidified milk products.
2. Improve the texture of low-fat milk and meat products.
3. Liberation of bioactive compounds from plant materials.
4. Flavor design of plant materials.
5. Restructuring fresh meat and fish.
6. Improve sensory quality of high-fiber and gluten-free breads.
7. Peeling of fruits and vegetables.
8. Improvement of foam quality and food texture.

Enzymes in Food Processing

Enzymes are most important to food technology because of their ability to act as catalysts, transforming raw materials into better quality food products.

Enzymes can change and improve the functional, nutritional and sensory qualities of ingredients and products, and therefore enzymes have found broad applications in processing and production of all kinds of food products. Food technologist selects those enzymes which can improve specific unit operation of food production.

Enzymes in Dairy Industry

Lactose, the sugar found in milk and whey, and its corresponding hydrolase, lactase or β-galactosidase, have been extensively used in breaking down lactose to glucose and galactose in milk processing to avoid lactose intolerance. Aminopeptidases are essential for the development of flavor in fermented milk products. The use of lipase and esterase are in flavor enhancement in cheese products. Chymosin is used in coagulation of milk for cheese making.

Enzymes in Bakery Technology

Enzymes are generally added to modify dough rheology, gas retention and crumb softness in bread manufacture. It improves dough rheology in the manufacture of pastry and biscuits, to change product softness in cake making and to reduce acrylamide formation in bakery products (Cauvain and Young, 2006). α-amylases are used to hydrolyze starch in flours and controlling the volume and crumb structure of bread. Enzymes such as hemicelluloses, xylanases, lipases and oxidases can directly or indirectly improve the strength of the gluten matrix and so improve the quality of the finished bread. Asparginase decreases the amount of acrylamide formed during baking.

Enzymes in Fruit and Vegetable Processing

Enzymes remain active even after harvest and produce undesirable effects on color, texture, taste, smell, and nutritional value. The enzymes are useful in the processing of fruits and vegetables, acting as hydrolysis of polysaccharides and facilitating the extraction of intracellular compounds. The common enzymes i.e., pectinases, amylases, and cellulases are helping in breaking down cell walls to extract fruit and vegetable juices. However, the addition of pectinases and amylases help break insoluble compounds to clarify the juice and sweeter.

It also increases the overall juice production. Other enzymes used in the juice industry are amylases, glucoamylases, cellulases, hemicellulase, laccase, naringinase and limoninase.

Amylase and glucoamylase are impotant for breaking down starch into glucose and clarifying cloudy juice, especially for apple juice. Cellulases and hemicellulase are acting on soluble pectin hydrolysis, on cell wall components with pectinases and lowering viscosity and maintenance of texture. Laccase is important for increasing the susceptibility of browning during storage.

Enzymes in Starch Processing

α-amylases causes a rapid decrease in substrate molecular weight and viscosity. β-amylases Produces low-molecular weight carbohydrates, such as maltose and -β- limit dextrin. Glycosyltransferases is used for increasing the number of branched points to obtain modified starch with improved functional properties such as higher solubility, lower viscosity and reduced retrogradation.

Conclusion

The use of enzymes in the food processing industry presents many advantages. It allows for high product yields and minimizes formation of by-products and unwanted side reactions, concomitantly easing downstream processing. It leads to environmentally friendly processes with low energy requirements and reduce production of carbon dioxide (CO_2). It also provides safe and high-quality products that associate with the requirements of increasingly public demand and regulatory agencies (Chandrasekaran *et al*., 2015; Mishra *et al*., 2017).

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E-ISSN: 2581 - 8317

Production Technology of China Aster

Article ID: 12075

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Introduction

China aster is one of the most popular and important annual flowering plants. It is half hardy annual. It is popular among all the garden annuals and rank next to chrysanthemum and marigold. It is grown easily under open field conditions and used as a loose flower and cut flowers both. It is also grown in the herbaceous border, flower beds and used as a bedding plant. Flowers have a prominent colours like blue, violet, lavender, rose, creamy, white etc. It is growing extensively in tropical and subtropical country for bedding and cut blooms during winter season. Plants are erect with hispid hairy branches bearing alternate, broadly ovate or triangular ovate, deeply and irregular toothed leaves. Flowers are used as a loose flower for the preparations of garland and also used as a cut flower for decoration purposes or decorating the vases. China aster flower has better vase life and remains fresh in the vases for longer period. Flowers have high demand in the market during winter season. Commercial importance of China aster is increasing especially in the southern states of India like Karnataka, Tamil Nādu, Andhra Pradesh and also in West Bengal and Maharashtra.

1. Botanical name – *Callistephus chinensis* L.
2. Family – Asteraceae.
3. Origin – China.
4. Chromosome no. – n=9, 2n= 18.

Climate

China aster is a winter season annual and commercially grown during the winter season. It requires cool climate for proper growth, development and flowering. It requires temperature range 20-30^0 C during day and 15-17^0 C during night with relative humidity 50-60%. China aster requires sunlight for longer time.

Soil

China aster is grown in wide variety and range of soil but sandy loam soil is best suitable for its cultivation. Soil should be well drained, rich with organic matter, porous, free from insect, pest and diseases. Soil pH should be 6.8-7.0.

Varieties of China Aster

China aster has different types and cultivars varying in growth habits, size, and shape of flowers and florets appearance. China aster has also very attractive flower colours in different cultivars in a particular type. Double flower cultivars are classified in to three types.

1. Tall: In this group the plant height varies from 70-90 cm. Important varieties are Powder Puffs, Princess, Giant Princess etc.

2. Medium: Plant height is in between 40-60 cm. Varieties are Giant comet, Pompon, Ostrich Feather, Liliput etc.

3. Dwarf: Height of the plant varies from 20-40 cm. Important varieties are Colour Carpet, Dwarf Chrysanthemum.

Varieties Released from Indian Institute of Horticultural Research, Bangalore (IIHR)

1. Arka aadya: It is an early flowering variety with pink colour flowers. Spreading growth habit and used for bedding purpose and loose flower.

2. Arka Archana: Flower colour is white, early flowering, spreading growth habit of plant. Mainly used for loose flowers and bedding purpose.

3. Arka Kamini: Colour of the flower is deep pink. Flower diameter is 6 cm and weight is 2 g. Stalk length of the flower is 30 cm and vase life of flower is about 8 days. Plant height is about 60 cm.

4. Arka Poornima: Flowers are powder puff type and pure white in colour. Plant height is about 50 cm. Flower diameter is 5 cm and weight of individual flower is 3.5 g. Vase life of the flower is 7 days and stalk length of the flower is about 25 cm.

5. Arka Shashank: Powdery puff type flowers with creamy white colour. Plant height is 55 cm, diameter of flower is 6 cm and weight of flower is 2.5 g. Stalk length of flower is about 25 cm and 9 days is a vase life of flower.

6. Violet Cushion: It bears pompon type flowers with violet colour. Size of the flower is 4.5 cm with 2.3 g of individual flower weight. Stalk length of flower is 20 cm and vase life of flower is 8 days.

Varieties released from NARP research station, Mahatma Phule Krishi Vidyapeeth, Rahuri, Ganeshkhind, Pune

1. Phule Ganesh Violet: It is medium tall, erect and late growing variety of China aster. It has double chrysanthemum type flowers with snow white colour. Yield 47.07 lakh flowers/ha. This variety is suitable for cut flower and for garland preparations.

2. Phule Ganesh Violet: This variety produces double chrysanthemum type medium size violet colour flowers. It is erect and semi erect variety. Yield 60.47 lakh flowers/ha.

3. Phule Ganesh Pink: It is an early and semi erect variety. It produces double chrysanthemum type rosy pink colour flowers with superior quality. Yield 43.03 lakh flowers/ha. It is used as cut flower and also suitable for cut flowers.

4. Phule Ganesh Purple: It is a semi erect variety. It has bright purple flowers. Yield is 46.82 lakh flowers/ha. Suitable for artistic floral decorations and management and for pasting work.

Land Preparation

Field should be ploughed well and 5-10 t of well decomposed manure is added at the time of land preparation. Two to three harrowing's are given after ploughing and incorporating FYM into the field. The stones and roots of the weeds should be collected from the field.

Propagation

China asters are commercially propagated by seeds. The seeds are tan to dark brown in colour. Seeds are collected from the healthy plants and used for the sowing immediately in next year season.

Nursery Raising for Seedlings

China aster seeds are generally raised on the raised beds. The seeds are generally sowing in the nursery during first week of September. The size of the beds should be 7.5 m long, 1.2 m wide and 20 cm high. Four beds of this size required for raising the seedlings for one hectare area. The beds are prepared by digging the soil and soil is mixed well with well decomposed FYM. The beds should be treated with 10% carbaryl dust and later drenched with captan or mancozeb (0.25%) before sowing of seeds. The size of the seeds is very fine that's why seeds are mixed in fine sieved river sand or FYM and sown thinly on beds in rows 10-12 cm apart from each other. Seeds germinate within one week. Seedlings are ready for transplanting after one to one and half month. About 1-1.5 kg seeds are required to prepare the seedlings for one hectare area.

Planting

Seedlings are ready for transplanting 30-45 days after sowing in the nursery. Seedlings are generally transplanted in the main field when they have three to four leaves. Transplanting is done during the morning or at evening hours to avoid the bright sunshine and temperature shock. Seedlings of the China aster are transplanted in the main field during middle of October month and it is the best time for transplanting. The soil around the root zone of the plant should be pressed firmly to avoid the air pockets. Light irrigation should be given immediately after transplanting.

Proper spacing is most important for the better vegetative growth, development and flower production. Normally recommended spacing for the China aster is 30x30 cm. Also, 45x30 cm, 45x20 cm, 45x45 cm spacing are suitable for China aster.

Irrigation

The frequency and intensity of irrigation depends upon the soil type and weather condition. China aster is a shallow rooted crop so it requires always moist soil during the entire period of growth. Generally, irrigation at 8-10 days interval is recommended in China aster cultivation.

Manures and Fertilizers

Proper manuring and fertilization are important for the successful cultivation of China aster. Deficiency of nutrients results in poor growth, development of plant and reduced flowering. Application of proper nutrients and fertilizer improves the growth, flowering, seed yield and disease resistance of the plant. Well decomposed farm yard manure is added in the field @ 5-10 t/ha. Generally, recommended dose of fertilizers is N: P: K (150:50:50 kg ha^{-1}) for proper growth, development and better flowering of China aster. Half dose of nitrogen and full dose of phosphorus and potassium is applied at the time of transplanting and remaining half dose of nitrogen is applied after 30 days of transplanting.

Cultural Operations

Weeding: Control of weeds is very necessary in the cultivation of China aster. Hand weeding with the help of labours is required to keep the field weed free. Three to four hand weeding is required during the entire period of growth. Weeding helps in loosening the soil and it increases aeration near the root zone.

Loosening the soil and earthing up: Loosening of soil improves the aeration in the root zone and increases the growth of plant. At least two earthing up operation is required at an interval of 30 days for avoiding lodging of plant and providing proper support to the plant.

Pinching: Pinching is an important practice in China aster cultivation and it found beneficial. It is given by removing the apical buds of plants at 30 days after transplanting. Pinching results in improving side branches, plants develop bushy structure and ultimately increases the number of flowers.

Diseases

1. Wilt: This disease is caused by *Fusarium oxysporum f. callistephi*. Infected plant is wilted and stunted growth of plant. Soaking of seeds for 30 min. in 0.1% solution of mercuric chloride are effective to prevent wilt occurrence.

2. Collar rot: It is caused by *phytopthora cryptogea* and occurs under high moisture condition. Plant is wilted suddenly; stem is rotten at the ground level and root rot. To avoid the occurrence of this disease, planting should not be done on the field which infected with the disease in previous years. Soil should be drenched with fungicides like captan, mancozeb and metalaxyl.

3. Gray mould: The causal organism of this disease is *Botrytis cinerea*. This disease appears 3-4 days after sowing of seeds in the nursery and 10-15 days after pricking out the seedlings. During cool and humid condition this disease spreads rapidly. By using light, well-drained soil, and by removing residues and weeds the incidence of this disease can be reduced. Spray of zineb or Indofil M-45 at 1.5 g/l water is effective for control of this disease.

4. Rust: It is caused by fungus *Coleosporium solidaginis*. Bright yellowish orange spots appear on the lower surface of leaves. It affects mostly the young plants. Spraying of benlate (0.1%) found effective to control this disease.

5. Leaf spot: It is caused by the fungus *Ascochyta asteris, Stemphylium callistephi* and *Septoria callistephi*. First of all, yellowish spots appear and then become dark brown to black. Size of the spots increases gradually. Lower portion of leaves infected first. Spray of bavistin (0.1%) or blitox (0.3%) control this disease.

6. Stem rot: *Pellicularia flamentosa* causes this disease. Rotting of stem is the main symptom. Use of clean soil and PCNB (terraclor) are effective to control.

Insects and Pests

1. Semilooper: The loopers feed on the leaves of plants. It can be controlled by spraying of quinolphos 0.5 ml/l or carbaryl 1.0 ml/l water.

2. Leaf hopper: It feeding on the leaves of plants and transmits the yellow virus. Dimecron 1 ml/l water or rogor at 2 ml/l water control the population of leaf hopper.

3. Spider mite: Spider mites are very small insects. Damage leaves become dull in colour. Spray of Kelthane 0.2% found beneficial to control population of spider mites.

4. Flower eating caterpillar: Flowers of China aster are mainly damaged by *Helicoverpa armigera* and *Phycita sp.* These insects feed on the flower heads. Imidacloprid 1ml/l of water control effectively flower eating caterpillar.

5. Leaf miner: It feeds on the foliage of China aster. Adults lay eggs on leaves and maggots feed on the leaves inside and flower calyx. Spray of Imidacloprid 0.5 ml/l water is effective.

Harvesting

Harvesting of flowers at right stage plays an important role in determining the quality of flowers. Generally, flowers are harvested in two different ways as a loose flower and cut flowers. Flowers are harvested without stem as a loose flower which are used for decoration, preparation of garlands and worship purpose. Also, flowers are harvested with stalk or the whole plant is harvested just above the ground when their original colour develops for cut flower purpose. Flowers are generally harvested in the morning time. The flowers are packed in bunches of 20 flowers in each bunch. In case of loose flower production, flowering is completed in 8-10 pickings in early varieties and 15-20 pickings in late varieties.

Postharvest Management

Immediately after harvesting flowers with stalk are kept in a container having clean water for removing the field heat. Lower leaves of the stalks should be removed to reduce the transpiration. Generally grading is done in China aster according to length of stalk, shape and size of the flower, colour and freshness. After grading, the flower bunches are prepared.

Flowers of China aster are arranged in vases and it is very popular due to its high vase life. When flowers are kept in vases it usually generated specific odour if kept for long time and it can be reduced by adding few drops of formaldehyde in the water.

Yield

Yield of China aster is depended on the weather, cultivar and cultural practices. Under normal condition 10-12 t flowers/ha produced whereas, with improved package of practices 18-20 t flowers/ha can be obtained.

Conclusion

China aster is winter season annual and it has very high demand in the market during winter season due to its different and attractive flower colours and high vase life. It is used for the decorations, garland preparations and decorating in the vases. By applying proper nutrition and following proper cultivation practices farmer can fetch a good income by growing this crop during winter season.

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Cultivation of Marigold

Article ID: 12076

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Introduction

Marigold is one of the most commercially grown flower crops which is used commonly as a loose flower for the preparation of garlands, floral decorations, used in the social and religious functions. It is most popular loose flowers and available throughout the year in the market. It is highly used in the garden as a bedding plant, in herbaceous borders and also used in the newly planted shrubberies for providing the color and also used in the flower beds. Marigold flower has good shelf life, attractive colour, and compact shape of the flower as compare to other flowers and remains fresh for 5-6 days at room temperature. There are two species of marigold grown commercially are African marigold (*Tagetes erecta*) and French marigold (*Tagetes patula*). Marigold is native to Central and Southern America specially Mexico and belongs to the family Asteraceae. African marigold is grown commercially while French marigold are growing the in rockery, hanging baskets, used for edging and window boxes. Now a days African marigold is grown commercially for the extraction of carotene pigments mainly xanthophylls. The carotenoid pigment from the African marigold is extracted from the petals and added to the feed of poultry for the intensification of yellow colour to the egg yolk. The major constituent of xanthophyll is lutein which is used for colouring the food stuff. The plantation of marigold has also been found beneficial to reduce the population of nematodes. By the plantation of marigold, root knot nematode *(Meloidogyne spp.)* can be managed effectively without the use of pesticide. Marigold flower has high demand in the market throughout the year but very high demand in the market during the festivals like Dashara and Diwali.

Climate

Marigold crop is hardy in nature and can grow well throughout the year under tropical and subtropical conditions but mild climate is suitable for proper growth, development and flowering. Marigold requires plenty of sunshine and cultivated in open sunny situation. The optimum temperature requires during growing period is 14.5-28.6^{0} C which greatly improves the flowering and the temperature above 35^{0}C affect the flower production. Plants and flowers are damaged by frost during severe winter.

Soil

Marigold is generally grown in the wide range of soil but, the soil should be well drained, friable, good water holding capacity and well aerated for better plant growth and flowering. French marigold grows well in light soil whereas African marigold required well drained moist soil. The pH of the soil should be 7.0-7.5 but also grown in slightly acidic soil with pH 5.8-6.2. pH range of 5.5-6.5 is also ideal for the cultivation of marigold.

Species of Marigold

1. *Tagetes erecta* (African marigold): It is commercially important growing species of marigold. It has medicinal, insecticidal importance and also used for the social, religious and decoration purposes. Plant is hardy, annual, plant height is about 90 cm erect and branched. It has single and double flowers and heads are large globular. The flower colour ranges are yellow, light yellow, orange, golden yellow, deep orange, golden orange, bright orange, canary yellow etc.

2. *Tagetes patula* (French marigold): The plant is hardy and bushy. Plant height is in between 30-40 cm. Stems are reddish colour and leaves are dark green in colour. Flower colours are yellow, orange and in various shades like light yellow, maroon blotches, gold and red colour etc. Mainly used in hanging baskets, edge and window boxes.

Important Varieties of African Marigold

Pusa Basanti Gainda, Pusa Narangi Gainda, Giant double African Orange, Giant Double African Yellow, Alaska, Pusa Arpita, Chrysanthemum Charm, Crackers Jack, Golden yellow, Golden age, Cupid Double Eagle etc.

Important Varieties of French Marigold

Arka Honey, Arka Pari, Bolero, Burpees Red and Gold, Petite White, Petite Yellow, Red Brocade, Rusty Red, Spray, Spun Gold, Eldorado, Dwarf Double etc.

Propagation

Marigolds are commercially propagated by seeds. It is also propagated by cuttings. Seed propagation is widely adopted because the plant raised by the seeds are vigorous, tall, yield better and good establish in field than cuttings.

Raising of Nursery for Seedlings

For nursery of marigold seedlings, seeds can be sown in pots, seed boxes, pro-trays, flat or raised beds. Generally, seeds are sown on the raised beds of size (3x1 m size and 15 cm height). Nursery beds are prepared by digging the soil and well decomposed FYM is added and mixed into the soil of beds. pH of the soil should be in between 6.0-6.2 for better germination. About 8-10 beds of 3x1 m size are required to prepare seedlings for one hectare area. After preparing the nursery beds, before sowing of seeds the beds are drenched with fungicides like captan or bavistin (0.2%). Seeds should be sown in rows (6.0-8.0 cm) apart from each other and 2 cm deep. After sowing, the seeds should be covered with fine sieved soil. The nursery beds should remain moist upto the seedlings get ready for transplanting. 1-1.5 kg seeds are required to prepare the seedlings for one hectare area. Sometimes, it may less depend on the germination percentage of seeds and 200-250 g seeds ha^{-1} in case of hybrid seed. Seed germination occurs 5-7 days after sowing. Seedlings become ready for transplanting in the main field 30-40 days after sowing.

Flowering Season, Time of Seed Sowing in Nursery and Time of Seedling Transplanting

Flowering season	Time of seed sowing	Transplanting time
Late rainy season	Mid of June	Mid July
Winter season	2nd week of September	Mid October
Summer season	January-February	February-March

Transplanting of Seedlings in the Main Field

Marigold seedlings are ready for transplanting 30-40 days after sowing the seeds in nursery. The seedlings should have 3-4 leaves for transplanting in the main field. Marigold seedlings are easily transplanted and established in the field without much mortality. Generally thin and long seedlings are not selected for transplanting. Also, very old seedlings are not desirable. Seedlings should be transplanted at the time of evening in the well-prepared field during rainy and summer season to avoid the shock of harsh weather or temperature. Soil should be pressed well around the plant to avoid air pockets around the root zone. Light irrigation should be given immediately after transplanting.

Proper spacing between the plants is required for better growth, development and higher flower yield. In general, 30x30 cm, 45x30 cm, 45x45 cm, 60x45 cm spacing is suitable for African marigold and 30x30 cm spacing is suitable for French marigold.

Manures and Fertilizers

Marigold is responded well to the fertilizers. Proper manure and fertilization are important for the growth, development and flower production of marigold. Well decomposed FYM @ 20-25 t ha^{-1} is mixed in the soil.

Generally recommended dose of N: P: K fertilizer to marigold is 100:50:50. Half dose of nitrogen and full dose of phosphorus and potassium is applied at the time of transplanting and remaining half dose of nitrogen is applied 30 days after transplanting. Also, foliar spray of some micronutrients like zinc, iron and boron are important for quality flower production of marigold.

Irrigation

Irrigation frequency and intensity is depended upon the soil and growing season. Frequent irrigation is required for light soil than heavy soil. Generally, irrigation is given 7-8 days interval. In summer season irrigation is given at 6-8 days interval whereas, in winter season 8-10 days interval and in rainy season irrigation is given as per need and depend on climate and rains.

Cultural Operations

Weeding: Weeds are the major problem in cultivation of marigold especially during rainy season. Weed affect the plant growth and flower production if it is not control in time. It competes with the plant for nutrients and water. In the initial stage of marigold immediately after transplanting of marigold seedlings weed grow faster than the seedlings and cover the plant. Generally manual weeding is given to the marigold. 3-4 weeding is given to keep the field weed free. Sometime it given for more time depend upon weed intensity in the field.

Hoeing: Hoeing is also an important intercultural operation in marigold. It creates the soil loose and improve aeration and remove the weeds. It makes the soil porous, loose which improve the plant growth. Hoeing is given with the bullock pair or also hand hoe is available in the market now a days.

Pinching: Pinching is the removal of apical growing point of the plant. Marigold grow upward and straight. Pinching helps in controlling the plant height and increasing the side branches. In marigold, pinching is given 30 or 40 days after transplanting. Pinching results in buildup of bushy plant and increases the number of branches and a greater number of flowers.

Disease Management

Diseases	Symptoms	Control measures
Damping off *(Rhizoctonia solani)*	This disease occurs in the nursery, appears brown spots girdling the radicle, later extend to plumule and cause pre-emergence mortality.	Soil should be drenched with copper oxychloride @ 3g/l, Avoid overwatering and proper drainage.
Collar rot (*Rhizoctonia solani*, *Phytophthora* sp., *Sclerotium rolfsii*)	Roots completely rotten under warm and humid condition. Black spots on the main stems.	Soil should be drenched with Carbendazim or metalaxyl @ 0.2% to reduce the disease incidence.
Alternaria blight (*Alternaria tagetica*, *A. zinniae* and *A. alternata*)	Pathogen develops in high atmospheric humidity and cause flower and bud rot. Small brown spots near the lower leaves.	Overhead irrigation should be avoided, application of Dithane M-45 @ 0.2% or blitox 0.4% controls the incidence of disease.
Botrytis flower blight *(Botrytis cinerea)*	Gray mass of spores are appeared on the infected tissues. Flower become brown and die.	Avoid frequent irrigation. Spraying of mancozeb @ 0.2% is effective.
Fusarium wilt *(Fusarium oxysporum)*	Wilting of plant.	Carbendazim @ 0.2% is effective to control.
Powdery mildew (*Oidium* sp. and *Leveillula taurica*)	Appears gray or white powder on leaves or branches of plant. Leaves become yellowish.	Dusting of sulphur powder or Kerathane (40 EC) @ 0.5%

Pest Management

Pest	Symptoms	Control measures
Red spider mite (*Tetranycus* sp.)	Suck the cell sap of plant and plants give a dusty appearance	Spray of Kelthane @ 2 ml/l water.

Hairy caterpillar *(Diacrisia obliqua)*	Caterpillar eat away the foliage of the plants	Spraying of Carbaryl @ 2 ml/l water
Leaf hopper (*Empoasea fabae* and *Macrosteles fascifrons*)	Cupping and rolling of leaves, wilting of shoot tips and leaflets.	Spraying of malathion or dimethoate @ 2 ml/l water

Harvesting of Flowers

Flowers are ready for harvesting 55-60 days after transplanting. The rainy season crop starts flowering in middle of September and it continues till December. Winter season crop starts flowering in middle of January and continue till March. Summer season crop starts flowering in middle of May and continues till June to July. Fully opened flowers are harvested by plucking. Flowers should be harvested during the morning or evening time. Field of marigold should be irrigated one or two days before the harvesting of flowers for maintaining freshness. The blooming period of the marigold is near about 2 to $2_{1/2}$ months.

Post-Harvest Management

After harvesting, the flowers are kept in a cool shady place. Harvested flowers are generally packed in gunny bags for transportation to the local market. For transported to the distant market flowers are packed in bamboo baskets and covered with the gunny bags and water is sprinkled over the gunny bags for maintaining freshness.

Yield

The average yield of fresh flower is 18-22 t ha^{-1} during rainy season, 15-18 t ha^{-1} during winter season and 12-14 t ha^{-1} during summer season. On an average 20-25 t ha^{-1} yield of fresh flower is obtained in African marigold and 12-16 t ha^{-1} in French marigold.

Conclusion

Marigold is one of the most important loose flowers with different shades and colours. It is used not only for the social, religious functions, preparations of garlands but also it has a medicinal and nematicidal property. It is available in the market throughout the year and also has a good demand. Hence, farmers can fetch a good return from the flower production of marigold. So, it is suggested to increase the focus towards the cultivation of marigold.

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E-ISSN: 2581 - 8317

Implementation of Artificial Intelligence in Agriculture

Article ID: 12077

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Abstract

Artificial Intelligence in agriculture has brought an agriculture revolution. This technology has protected crop yields against a variety of factors such as climate change, population increase, labor issues, and food security concerns. Artificial intelligence applications in agriculture, such as irrigation, weeding and spraying, using sensors and other techniques incorporated in robots and drones. These technologies reduce the use of water, pesticides, and herbicides, maintain soil fertility, and aid in the efficient use of manpower, so increasing productivity and improving quality.

Introduction

Agriculture contributes significantly to the economy. Agriculture automation is a major source of concern and a hot topic around the world. The world's population is rapidly growing, and with it comes increased demand for food and work. The farmers' traditional practices were not sufficient to meet these objectives (Talaviya, 2020). A system for harvest planning based on the coupling of crop assignment with vehicle routing is provided. Artificial Intelligence (AI) has begun to play a big part in our daily lives, extending our perceptions and abilities to influence the environment around us. With this new technology, workers who formerly worked in only a few industrial areas can now work in a variety of fields. Biology, linguistics, computer science, mathematics, psychology, and engineering are just a few of the fields that AI is founded on.

The main idea behind AI is to create a system that works similarly to the human brain (Parekh et al., 2020; Jani et al., 2019) This technology is perpetrated by researching how the human brain thinks, learns, makes judgments, and collaborates when addressing a problem, then developing intelligent software and systems on this foundation. These intelligent gadgets, like the human brain, are supplied with training data and then provide us with the desired result for every valid input. AI encompasses a wide range of fields, including Machine Learning (ML) and Deep Learning (DL). While AI is the study of creating intelligent computers and programmes, machine learning (ML) is the ability to learn anything without being explicitly programmed, and deep neural network learning (DL) is the learning of deep neural networks (Kodali and Sahu, 2016).

The primary goal of AI is to make problem solving easier, which may be accomplished through the deployment of artificial neural networks (ANN). An artificial neural network (ANN) is a processing algorithm or hardware that is inspired by the design and operation of the human brain (Shah et al., 2020). Self-organization and adaptive learning are extraordinary abilities of neural networks. In subjects as diverse as computer science, mathematics, physics, engineering image/signal processing, economics/finance, philosophy, linguistics, and neurology, it has largely superseded traditional approaches. ANN goes through a learning process. When there is a change in the environment, learning is the process of adjusting to that change. There are two types of learning techniques: supervised and unsupervised.

In agriculture, artificial intelligence (AI) is a new technology. Today's agriculture system has been elevated to a new level due to AI-based equipment and technologies. Crop productivity, real-time monitoring, harvesting, processing, and marketing have all improved as a result of this technology (Yang et al., 2007). The agro-based sector has benefited greatly from the latest technologies of automated systems using farm robots and drones. Several high-tech computer-based systems have been developed to identify various critical factors such as weed detection, yield detection, crop quality, and a variety of other ways (Liakos et al., 2018).

Impact of AI on Agriculture

AI-based technologies aid in the improvement of efficiency in all fields and the management of difficulties faced by numerous businesses, including crop yield, irrigation, soil content sensing, crop monitoring, weeding, and crop establishment in the agricultural sector (Kim et al., 2008). Agricultural robots are being developed in order to provide high-value AI applications in the aforementioned industry. The agriculture sector is experiencing a crisis as the world population grows, but AI has the potential to provide a much-needed answer. Farmers have been able to generate more output with less input and increase the quality of their output, as well as ensure a faster time to market for their harvested crops, thanks to AI-based technology solutions. The following are some of the ways that AI has helped the agricultural sector:

1. Image recognition and perception: Autonomous UAVs and its applications, such as recognition and surveillance, human body detection and geolocation, search and rescue, and forest fire detection, have sparked increased interest in recent years. Drones or unmanned aerial vehicles (UAVs) are becoming increasingly popular for reaching great heights and distances and carrying out a variety of applications due to their versatility, as well as amazing imaging technology that covers everything from delivery to photography, the ability to be piloted with a remote controller, and the devices being dexterous in the air, which allows us to do a lot with these devices.

2. Skills and workforce: Artificial intelligence enables farmers to collect vast amounts of data from government and public websites, evaluate it, and provide solutions to a variety of complex challenges. It also enables us to use smarter irrigation methods, resulting in higher yields for farmers. Farming will be discovered to be a mix of technology and biological skills in the near future as a result of artificial intelligence, which will not only provide a better outcome in terms of consistency for all farmers, but will also reduce their losses and workloads.

3. Maximize the output: According to Ferguson et al. (1991), the maximum performance level for all plants is determined by variety selection and seed quality. Emerging technologies have aided in the best crop selection and have even improved the selection of hybrid seed options that are best suited to the needs of farmers. It has been adopted by determining how seeds react to different weather conditions and soil types. Plant diseases are less likely as a result of this data collection. We can now meet market trends, yearly outcomes, and customer needs, allowing farmers to maximise agricultural returns more efficiently.

4. Chatbots for farmers: Conversational virtual assistants, often known as chatbots, automate interactions with end-users. We can now interpret natural language and communicate with users in a more tailored way apparently to artificial intelligence-powered chatbots and machine learning algorithms. They are mostly equipped for retail, travel, and media, but agriculture has taken use of this capacity by supporting farmers in receiving answers to their unanswered queries, as well as providing guidance and other recommendations.

Conclusion

One of the main challenges for the implementation of artificial intelligence (AI) in agriculture includes the low replicability and the corresponding difficulty in systematic data gathering, as no two fields are exactly alike. Overall, AI technologies improve farm decision support by monitoring circumstances and optimizing output, allowing farmers to apply the best number of inputs for each crop, increasing yields while reducing water use and greenhouse gas emissions. New concepts based on autonomous and intelligent robots for plant and soil sample retrieval, as well as successful livestock management, will be developed in the future.

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E-ISSN: 2581 - 8317

Nanotechnology in Sustainable Agriculture: Recent Developments, Challenges, and Perspectives

Article ID: 12078

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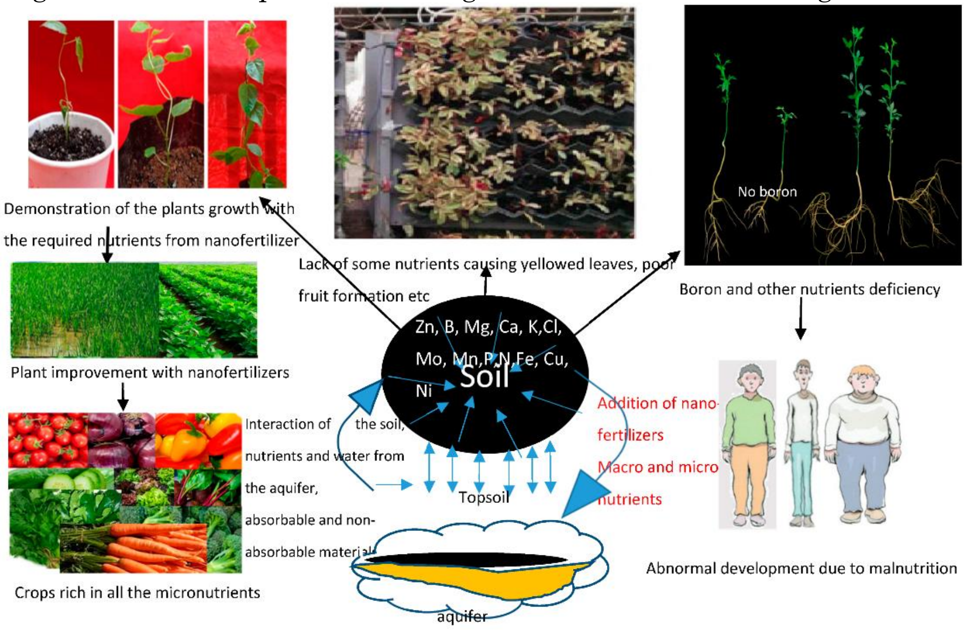
Importance of Nanotechnology in Sustainable Agriculture

Nanotechnology keeps track on one of the most important agricultural management processes, thanks to its small size. Furthermore, many potential benefits, such as improved food quality and safety, reduced agricultural inputs, enhanced absorption of nanoscale nutrients from the soil, and so on, make nanotechnology a resonant encumbrance. Sustainability, susceptibility, human health, and a healthy existence are all difficulties that agriculture, food, and natural resources face. In agriculture, nanoparticles aim to reduce the amount of chemicals spread, reduce nutrient losses in fertilisation, and boost output through insect and nutrient management. Nanotechnology has the potential to benefit the agriculture and food industries by developing revolutionary nanotools for disease management, nutrient absorption capacity, and other applications. Specific applications such as nanofertilizers and nanopesticides to trail products and nutrients levels to increase productivity without decontaminating soils, waters, and protection against several insect pests and microbial diseases are among the significant interests of using nanotechnology in agriculture. Nanotechnology can be used as sensors to monitor the soil quality in agricultural fields, ensuring the health of the plants.

Introduction

Nanotechnology has the potential to boost productivity by controlling nutrients and contributing to the monitoring of water quality and pesticides for agriculture's long-term sustainability. Nanomaterials have so many different assets and activities that a broad assessment of their health and environmental concerns is impossible. Chemical composition, form, surface structure, surface charge, behaviour, level of particle aggregation (clumping) or disaggregation, and other properties of NPs that determine toxicity may be associated with manufactured NPs. The application of nanotechnology research in agriculture has become a vital and perhaps critical aspect for long-term development. Nanotubes, fullerenes, biosensors, controlled delivery systems, nanofiltration, and other agri-food applications were noticed. This method has been shown to be effective in agricultural field resource management, drug delivery systems in plants, and soil fertility maintenance. Furthermore, it is continually assessed in the utilisation of biomass and agricultural waste, as well as in food processing and packaging systems and risk assessment. Nanosensors have recently been widely used in agriculture due to their strengths and speed in environmental monitoring of contamination in soils and water. Biosensors, electrochemical sensors, optical sensors, and devices based on nano-detection technologies will be the major instruments for detecting heavy metals in the trace range.

Nanomaterials not only directly catalyse the breakdown of waste and hazardous materials, but they also help microorganisms degrade waste and harmful materials more efficiently. Toxins and hazardous compounds are broken down or removed from agricultural soil and water via bioremediation. Other terminology commonly used include bioremediation (helpful bacteria), phytoremediation (plants), and mycoremediation (mycoremediation) (fungi and mushrooms). Microorganisms can thus eliminate heavy metals from soil and water in an environmentally friendly and effective manner via bioremediation. As a result, agricultural bioremediation aids in the development of long-term remediation solutions to resolve and restore the soil's natural state. It's an intriguing phenomenon to think about the nano–nano interaction in terms of removing hazardous components from agricultural soil and making it more sustainable.



Nanofertilizers

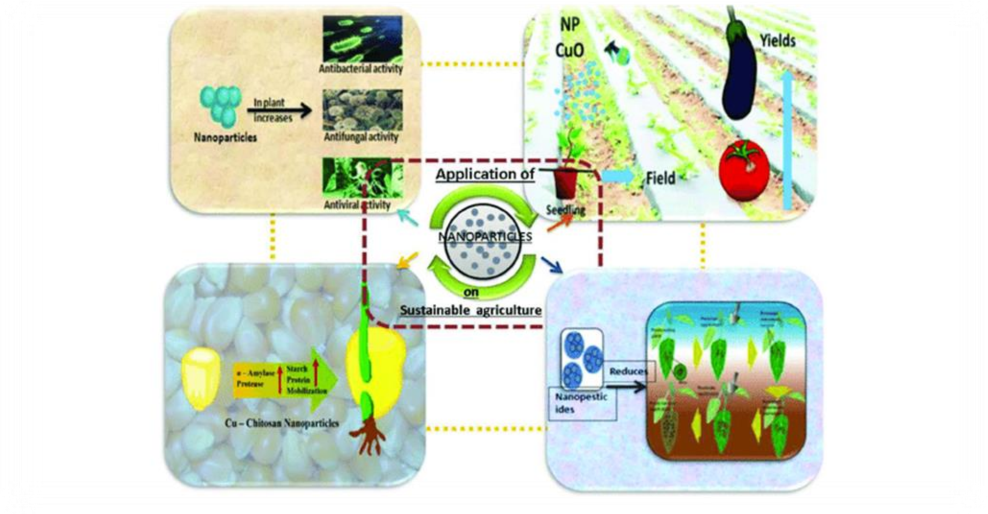
Nanofertilizers may include nano zinc, silica, iron, and titanium dioxide, as well as ZnCdSe/ZnS core shell QDs, InP/ZnS core shell QDs, Mn/ZnSe QDs, gold nanorods, core shell QDs, and core shell QDs, among other things. Sustainable bio-based economies that use eco-efficient bio-processes and renewable bio-resources will continue to reduce and replace harmful materials in existing applications in the future, and thus will play a major role (key strategic challenge) in the development of the technologies needed to address the 21st century. The accumulation of knowledge in the domains of ecology, biology, biodiversity, material science, biotechnology, and engineering bring up opportunities for increasing biomass productivity as well as highly efficient utilisation of biomass and organic wastes.

Nanopesticides

In the future, the application of nanomaterials in plant protection and food production will be under-explored. Insect pests are well-known in agricultural fields and in agricultural goods, thus NPs may play an important role in the management of insect pests and host infections. A new nano encapsulated pesticide formulation with improved solubility, specificity, permeability, and stability has just been developed. These benefits are mostly obtained by either preventing early degradation of the encapsulated active components or boosting their pest control activity for a longer period of time. The quality of products of desired chemicals distribution to the target biological process is developed using microencapsulation-like nanoencapsulation. Few chemical companies have recently openly advertised nanoscale pesticides for sale as "microencapsulated insecticides." Some Syngenta (Switzerland) products, such as Karate ZEON, Subdue MAXX, Ospray's Chyella, Penncap-M, and BASF microencapsulated insecticides, may be suitable for nanoscale use.

Growth of Cultivated Plants and its Sustainability

The food chain is dominated by agriculture host plants. Plants are now being produced on watery media in addition to agricultural grounds. In the plant host, multiple NPs of iron oxide (magnetite), a magnetic form of iron ore, can naturally develop. The capacity of iron (II, III) oxide NPs (Fe_3O_4 -NPs) to accumulate in Lepidium sativum and Pisum sativum plants is intriguing. As a result, this type of finding strongly suggests that the roles associated with NPs exist in the natural ecosystem. Furthermore, the use of polymeric NPs in agriculture, particularly when loaded with pesticides derived from plants, is unique and becoming more widespread. If nanoparticles containing agricultural plants are free of harmful nanocomposite, there is a one-of-a-kind opportunity to increase agricultural crop yield. As a result, introducing designed (chemical or green) NPs into the agricultural field should always be a routine check-up to maintain an environmentally friendly agricultural field.



Nanotechnologies in Food Industry

Pathogen identification and diagnosis can be aided by nanoscale biosensors. Nanotechnology has the potential to deliver bioactive elements in foods to hosts while also improving nanoscale knowledge of food components. It also aids in the development of nanoscale filtering devices for food texture manipulation.

Food Process

Nanotechnology has recently become popular in food processing, including nanocarrier systems for vitamin and supplement delivery, as well as organic nano-sized additives for food, supplements, and animal feed. Many foods already contain NP in its natural state. Milk contains casein, a nanoscale type of milk protein, while meat is made up of protein filaments, which can also be categorised as nanomaterials. The organisation and structures of proteins inside these products determine the texture and qualities of these products.

Food Packaging and Labelling

Maintaining crucial variables such as quality, safety, freshness, and taste along the food supply chain necessitates producers packaging and labelling their products. For researchers and manufacturers, developing smart packages that can give relevant information remains a major problem. Some packaging materials incorporating "nanosensors" to detect the oxidation process in food have recently been developed and tested in the food business.


Future Perspectives

Sustainable agriculture must be viewed as an ecological method in which abiotic–biotic living organisms coexist in harmony with food chains and their associated energy balances. To maximise agricultural productivity, new technology, modernization, increasing use of nano-chemicals, specialisation, and government regulations are implemented. To get out of this dilemma, the food business must implement cutting-edge technology. As a result, nanotechnology, which has very unique properties in the food supply chain (from the field to the table, crop production, use of agro-chemicals such as nanofertilizers, nanopesticides, nanoherbicides, etc. precision farming techniques, intelligent feed, enhancement of food texture and quality, bioavailability/nutrient values, packaging and labelling, etc.) is the new and future technology. In the subject of agricultural nanotechnology or nanofoods, some focused areas may require additional attention in the near future.

Conclusion

Agriculture, being the sole source of human food, should create from intermediate and final inputs using well-established technology. As a result, contemporary agricultural knowledge is required. Despite their relative advantages in the agricultural process, developing countries continue to suffer from a lack of high-value food products. Despite the fact that much information about individual nanoparticles is available, the toxicity level of many NPs is still unknown, limiting their application due to a lack of risk assessments and effects on human health. For this technology to be exploited, it will require the development of a comprehensive database and warning system, as well as international cooperation on regulation and legislation.

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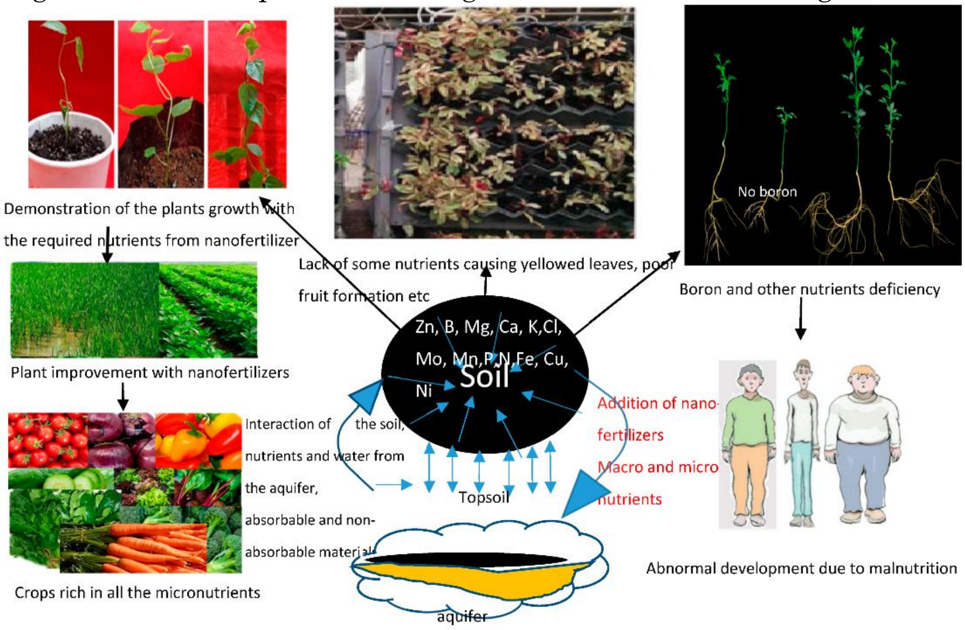

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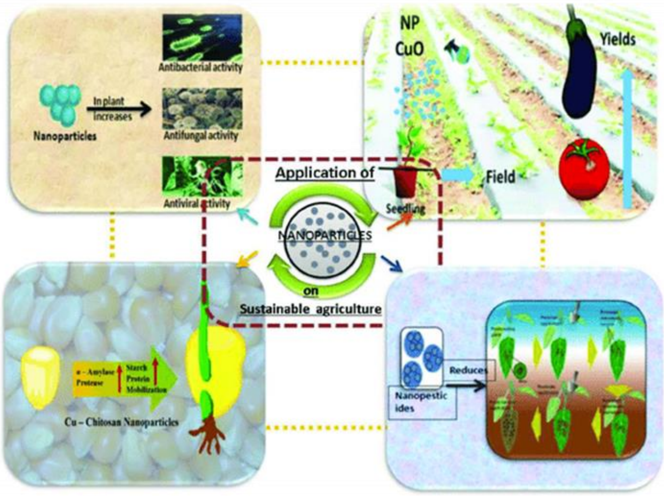
In the future, the application of nanomaterials in plant protection and food production will be under-explored. Insect pests are well-known in agricultural fields and in agricultural goods, thus NPs may play an important role in the management of insect pests and host infections. A new nano encapsulated pesticide formulation with improved solubility, specificity, permeability, and stability has just been developed. These benefits are mostly obtained by either preventing early degradation of the encapsulated active components or boosting their pest control activity for a longer period of time. The quality of products of desired chemicals distribution to the target biological process is developed using microencapsulation-like nanoencapsulation. Few chemical companies have recently openly advertised nanoscale pesticides for sale as "microencapsulated insecticides." Some Syngenta (Switzerland) products, such as Karate ZEON, Subdue MAXX, Ospray's Chyella, Penncap-M, and BASF microencapsulated insecticides, may be suitable for nanoscale use.

Growth of Cultivated Plants and its Sustainability

The food chain is dominated by agriculture host plants. Plants are now being produced on watery media in addition to agricultural grounds. In the plant host, multiple NPs of iron oxide (magnetite), a magnetic form of iron ore, can naturally develop. The capacity of iron (II, III) oxide NPs (Fe_3O_4 -NPs) to accumulate in Lepidium sativum and Pisum sativum plants is intriguing. As a result, this type of finding strongly suggests that the roles associated with NPs exist in the natural ecosystem. Furthermore, the use of polymeric NPs in agriculture, particularly when loaded with pesticides derived from plants, is unique and becoming more widespread. If nanoparticles containing agricultural plants are free of harmful nanocomposite, there is a one-of-a-kind opportunity to increase agricultural crop yield. As a result, introducing designed (chemical or green) NPs into the agricultural field should always be a routine check-up to maintain an environmentally friendly agricultural field.



Nanotechnologies in Food Industry

Pathogen identification and diagnosis can be aided by nanoscale biosensors. Nanotechnology has the potential to deliver bioactive elements in foods to hosts while also improving nanoscale knowledge of food components. It also aids in the development of nanoscale filtering devices for food texture manipulation.

Food Process

Nanotechnology has recently become popular in food processing, including nanocarrier systems for vitamin and supplement delivery, as well as organic nano-sized additives for food, supplements, and animal feed. Many foods already contain NP in its natural state. Milk contains casein, a nanoscale type of milk protein, while meat is made up of protein filaments, which can also be categorised as nanomaterials. The organisation and structures of proteins inside these products determine the texture and qualities of these products.

Food Packaging and Labelling

Maintaining crucial variables such as quality, safety, freshness, and taste along the food supply chain necessitates producers packaging and labelling their products. For researchers and manufacturers, developing smart packages that can give relevant information remains a major problem. Some packaging materials incorporating "nanosensors" to detect the oxidation process in food have recently been developed and tested in the food business.


Future Perspectives

Sustainable agriculture must be viewed as an ecological method in which abiotic–biotic living organisms coexist in harmony with food chains and their associated energy balances. To maximise agricultural productivity, new technology, modernization, increasing use of nano-chemicals, specialisation, and government regulations are implemented. To get out of this dilemma, the food business must implement cutting-edge technology. As a result, nanotechnology, which has very unique properties in the food supply chain (from the field to the table, crop production, use of agro-chemicals such as nanofertilizers, nanopesticides, nanoherbicides, etc. precision farming techniques, intelligent feed, enhancement of food texture and quality, bioavailability/nutrient values, packaging and labelling, etc.) is the new and future technology. In the subject of agricultural nanotechnology or nanofoods, some focused areas may require additional attention in the near future.

Conclusion

Agriculture, being the sole source of human food, should create from intermediate and final inputs using well-established technology. As a result, contemporary agricultural knowledge is required. Despite their relative advantages in the agricultural process, developing countries continue to suffer from a lack of high-value food products. Despite the fact that much information about individual nanoparticles is available, the toxicity level of many NPs is still unknown, limiting their application due to a lack of risk assessments and effects on human health. For this technology to be exploited, it will require the development of a comprehensive database and warning system, as well as international cooperation on regulation and legislation.

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AGRICULTURE & FOOD: E-NEWSLETTER
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E-ISSN: 2581 - 8317

Bioremediation of Soil and Water Resources by Mushrooms for Conservation and Management of Environment

Article ID: 12079

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Abstract

The major environment problems today are the contamination of soil, water, air by toxic chemical and use of pesticides in agriculture. These chemicals include polycyclic aromatic hydrocarbon, ethane, pentachloro - phenol, benzene, toluene, polychlorinated biphenyls, toluene, trinitrotoluene. Bioremediation concerning ability of mushroom and their enzymes to bio-transform pesticide. It is now becoming that mushroom play an important role in degrading organic materials in the ecosystem and has potential for remediating contaminated soil and water.

Mushroom forming fungi are amongst nature most powerful decomposer. They secrete strong extra-cellular enzymes due to their aggressive growth and biomass production. These enzymes include lignin peroxides, manganese peroxidase and lactase etc. The process of using microorganism to remove organic wastes, prevent pollution, or for environmental clean-up.

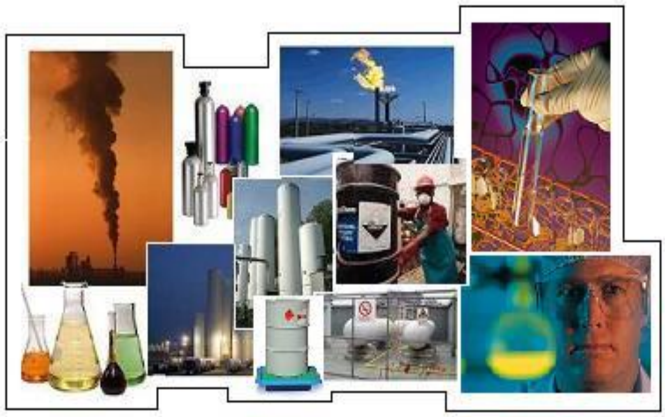
Bioremediation depend largely on the enzymatic activities of living organism, usually microbes, to catalyze the destruction of pollutants or their transformation to less harmful forms. The fungi to decompose the contaminants, finally to CO_2 and H_2O.*Phanerochaete chrysosporium, Agaricusbisporus, Trametesversicolar, and Pleurotusostreatus etc.* have been reported in polluted sites. The contaminated are unfit for agriculture could be both cleaned and made to yield a nutritious food crop.

Keywords: Mushrooms, Chemicals, water and soil.

Introduction

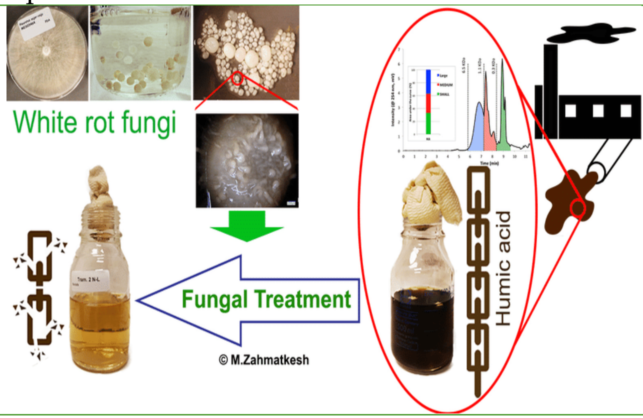
1. The major environment problems day are the contamination of soil, water, air by toxic chemical and use of pesticides in agriculture.
2. These chemicals include polycyclic aromatic hydrocarbon, ethane, pentachloro - phenol, benzene, toluene, polychlorinated biphenyls, toluene, trinitrotoluene.
3. Bioremediation concerning ability of mushroom and their enzymes to bio-transform pesticide.

	
Source: Internet, Water radical remedies	**Source: Internet, Remedies of petroleum wastes**

	
Source: Internet Chemical released from research Centre, plastic industry, and pharmaceutical industry	

Importance

1. It is now becoming that mushroom play an important role in degrading organic materials in the ecosystem and has potential for remediating contaminated soil and water.
2. Mushroom forming fungi are amongst nature most powerful decomposer.
3. They secreting strongextra cellularenzymes due to their aggressive growth and biomass production.
4. These enzymes include lignin peroxidases, manganese peroxidase and laccase etc.

	
Source: internet, Mushroom grows on	**Source: internet, Bioremediation of humic acid**

Bioremediation

1. The process of using microorganism to remove organic wastes, prevent pollution, or for environmental clean-up.
2. Bioremediation depend largely on the enzymatic activities of living organism, usually microbes, to catalyze the destruction of pollutants or their transformation to less harmful forms.

	
Source: internet, fungal growth on	**Source: internet, fungal growth on Agri**

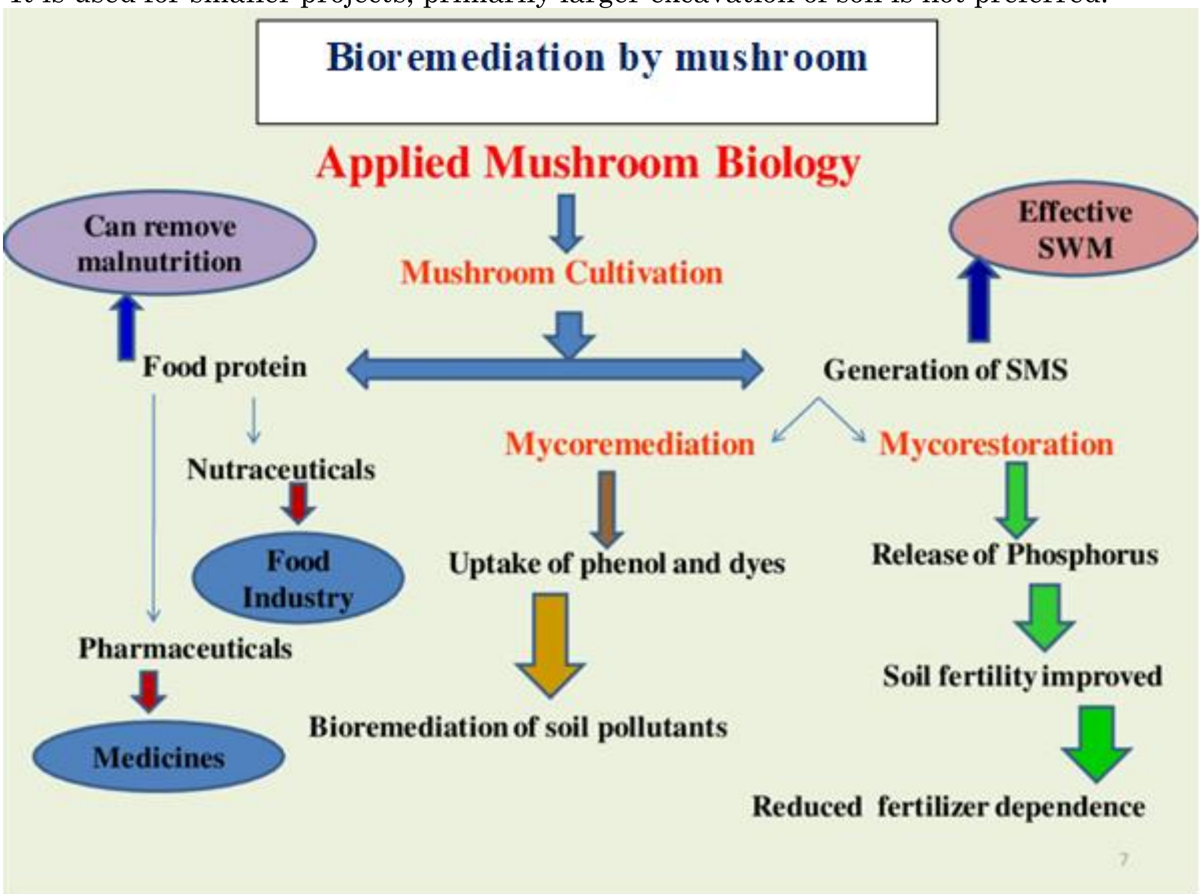
Types of Bioremediations

1. In – situ bioremediation:

a. On –site bioremediation.
b. Cheapest and most efficient.
c. Site disturbance is minimized.

2. Ex- situ bioremediation:

a. Contaminated land is taken out the area to be cleaned up by the organisms.
b. Expensive process.
c. Causes damage to the area.
d. It involves land farming, composting, and bioreactors.
e. It is used for smaller projects; primarily larger excavation of soil is not preferred.



Mushroom Used as Biotransformation

White rot fungi have been used for biotransformation of pesticides, degradation of petroleum hydrocarbons and lignocellulolytic wastes in the pulp and paper industry.

List of Mushrooms

1. *Phanerochaetechrysporium*.
2. *Agaricusbisporus*.
3. *Trametes versicolor*.
4. *Pleurotusostreatus*.
5. *Pleurotuspulmonarius*.
6. *Lentinus squarrosulus*.
7. *Pleurotus tuber – regium*.


Source: Internet, Mushroom grown on wastes

White – Rot Fungi Degradation System

1. The main mechanism of biodegradation employed by this group of fungi is the degradation system of enzymes.
2. They have able to mineralize a wide range of highly recalcitrant organ pollutants is similar to lignin.
3. The major component of lignin degradation system includes lignin peroxidase, manganese peroxidase Hydrogen peroxide producing enzyme and laccase although not all lignolytic fungi shows three types of enzymatic activity.

Potential of Mushroom in Bioremediation

Phanerochaete chrysosporium

1. *Phanerochaetechrysosporium* has been known to degrade lignin macro molecules and many types of organ pollutants.
2. Such as polycyclic aromatic hydrocarbon, polychlorinated biphenyls and dioxins, chlorophenol, choriogenins, nitrocranditics, synthetic dyes and different pesticides.
3. *P. chrysosporium* has been shown to affect the bioleaching of organic dyes.

Source: internet, Phanerochaete

Source: internet, Phanerochaetesoridida

Phanerochaeteflavedo – alba

1. *Phanerochaeteflavido – alba* has been able to decolorize olive oil waste water.
2. Decolorization was accompanied by a 90% decrease in the OMW phenolic content.

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Trametesversicolar

1. *Trametesversicolar*produced three lignolytic enzymes with efficient degradation capacity on lignin, polycyclic aromatic hydrocarbon, polychlorinated biphenyl mixture and a number of synthetic dyes.
2. *T. versicolor* and its enzymes delignify and to bleach Kraft pulp and efficiently dechlorinate and decolorize bleach Kraft effluents and paper industry.

Fig: (Source Internet) Trametesspp

Pleurotusostreatus

1. *Pleurotusostreatus*is able to degrade polycyclic aromatic hydrocarbon.
2. It has the ability to degrade PAH in non-sterile soil both in the presence and absence of cadmium and mercury.
3. It has catalyzed humification of anthracene, benzo pyrene and flora in two PAH- contaminated soil from a manufactured gas facility and an abandoned electric cooping plant.

(Source: internet) *Pleurotusostreatus*

Pleurotus tuber- Regium

P. tuber – regium is another fungus ability to ameliorate crude oil polluted soil.

Fungus increases in nutrient contents:
1. Organic content, carbon, potassium: 1-40%
2. Increase in copper content in soil: 10%
3. Decrease engine oil concentration: 20-40%
4. Bioaccumulation of zinc and nickel: 20%
5. Growth on spent lubricating oil and yield: 98% / 79.56g

Source: internet, *Pleurotus tuber*

Lentinus squarrosulus

1. *L. squarrosulus*to mineralize soil contaminated with various concentration of crude oil: 1-40%
2. It increases organic matter, carbon and phosphorus and decrease nitrogen and potassium.
3. A relative high percentage degradation of total petroleum hydrocarbon: 64.05%
4. The rapid mycelia growth and enhanced enzymes production have biotechnological application for wood and pulp, textile, tanning and oil spill.

Source: internet, *Lentinus*

Pleurotuspulmonaris

1. The management of cement and battery polluted soil.
2. Increase in carbon content, organic matter, phosphorus and potassium and decrease in nitrogen, calcium, and PH.
3. A significant decrease in the copper, manganese and nickel contents of the soil.
4. The polyaromatic hydrocarbon content also decrease from 6.86% after 10 weeks.

Source: internet, *Pleurotuspulmonaris*

Agaricusbisporus

1. Bioremediation of soil multi-polluted with Pb(lead) and PAH.
2. The three-application produced slight Pb mobilization (0.3%).
3. *A. Bosporus* substrate application is the key to achieving maximum PAH removal.
4. The increment of available Pb did not decrease the PAH biodegradation by *A. bisporus.*

Source: internet, *Agaricusbisporus*

Conclusion

The application of white-rot fungi in mycoremediation soil and water for economical and ecologically methods for environmental remediation, the use of mushroom is a very good approach and solution.

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E-ISSN: 2581 - 8317

Microbes in Rhizosphere

Article ID: 12080

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Introduction

Rhizosphere is the zone of soil that is significantly influenced by living roots. Usually extends about 2mm out from the root surface. The rhizosphere is enriched in organic material due to root exudates and sloughed off root cells. Microbial activity in the rhizosphere may be 2 – 10 times greater than in the bulk soil. The Rhizosphere is the zone surrounding the roots of plants in which complex relations exist among the plant, the soil microorganisms and the soil itself. The plant roots and the biofilm associated with them can profoundly, influence the chemistry of the soil including pH and the transformation of mineral compounds.

Bacteria

The greater rhizosphere effect is observed with bacteria (R: S values ranging from 10-20 or more) than with actinomycetes and fungi. The most common genera of bacteria are: *Pseudomonas, Arthrobacter, Agrobacterium, Alcaligenes, Mycobacterium, Flavobacter, Cellulomonas, Micrococcus* and others have been reported to be either abundant or sparse in the rhizosphere. The aerobic bacteria are relatively less in the rhizosphere because of the reduced oxygen levels due to root respiration. The bacterial population in the rhizosphere is enormous in the ranging from 10^8 to 10^9 per gram of rhizosphere soil. They cover about 4-10% of the total root area occurring profusely on the root hair region and rarely in the root tips.

Fungi

In contrast to their effects on bacteria, plant roots do not alter / enhance the total count of fungi in the rhizosphere. The R:S ratio of fungal population is believed to be narrow in most of the plants, usually not exceeding to 10.

Actinomycetes, Protozoa and Algae

Stimulation of actinomycetes in the rhizosphere has not been studied in much detail so far. It is generally understood that the actinomycetes are less stimulated in the rhizosphere than bacteria. However, when antagonistic actinomycetes increase in number they suppress bacteria. Actinomycetes may also increase in number when antibacterial agents are sprayed on the crop. Among actinomycete, the phosphate solubilizes (eg. *Nocardia, Streptomyces*) have a dominant role to play. As rule actinomycetes, protozoa and algae are not significantly influenced by their proximity to the plant roots and their R: S ratios rarely exceed 2 to 3: 1 and around roots of plants, R: S ratio for these microorganisms may go to high.

Factors Affecting Microbial Flora of the Rhizosphere / Rhizosphere Effect

1. Soil type and its moisture: In general, microbial activity and population is high in the rhizosphere region of the plants grown in sandy soils and least in the high humus soils, and rhizosphere organisms are more when the soil moisture is low. Thus, the rhizosphere effect is more in the sandy soils with low moisture content.

2. Soil amendments and fertilizers: Crop residues, animal manure and chemical fertilizers applied to the soil cause no appreciable effect on the quantitative or qualitative differences in the microflora of rhizosphere. In general, the character of vegetations more important than the fertility level of the soil.

3. Soil pH/ Rhizosphere 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 or non-rhizosphere soil. Rhizosphere effect for bacteria and protozoa is more in slightly alkaline soil and for that of fungi is more in acidic soils.

4. Proximity of root with Soil: Soil samples taken progressively closer to the root system have increasingly greater population of bacteria, and actinomycetes and decreases with the distance and depth from the root system. Rhizosphere effect decline sharply with increasing distance between plant root and soil.

5. Plant Species: In general, legumes show / produce a more pronounced rhizosphere effect than grasses or cereals. Biennials, due to their long growth period exert more prolonged stimulation on rhizosphere effect than annuals.

6. Age of Plant: The age of plant also alters the rhizosphere microflora and the stage of plant maturity controls the magnitude of rhizosphere effect and degree of response to specific microorganisms. The rhizosphere microflora increases in number with the age of the plant and reaching at peak during flowering which is the most active period of plant growth and metabolism. Hence, the rhizosphere effect was found to be more at the time of flowering than in the seedling or full maturity stage of the plants.

7. Root / exudates /excretion: One of the most important factors responsible for rhizosphere effect is the availability of a great variety of organic substances at the root region by way of root exudates/excretions. The quantitative and qualitative differences in the microflora of the rhizosphere from that of general soil are mainly due to influences of root exudates.

Rhizodeposition

Release of organics form roots (5-20% roots exucants): Rhizodeposition describes that total carbon transfer form root to soil. Plants roots secrete various nutrients rich compund into the surrounding soils,this process called Rhizodeposition. Rhizodeposition can amount up to 25% of newly fixed photosynthates. This nutritional enrichment around roots creats unique environment for soil microorganism including the rhizosphere (that's volume of soil around roots influenced by roots exudation) and the rhizoplane (the immediate root epidermal surface that interfaces that rhizosphere soil. It includes releases come from secretion, exudates, lysates, mucilage and mucigel. The term rhizodeposition includes (Root exucates, mucilage, death & decay part of root).

Rhizosphere Effect

Compared to non-rooted bulk soil, the rhizospheric soil around the plant root contains much larger population of microorganism. A stimulation can be put on a quantitative basis by the use of the R : S ratio. R : S ratio = number of microorganisms in the rhizosphere soil : number of microorganisms in the non-rhizosphere soil. R/S > 1-- good stimulation, R/S = 1-- no stimulation, R/S < 1—inhibition.

Root Exudates

Plant affects the rhizosphere microorganisms through the release of root exudates. Small molecules that are released from plant roots, which include sugars, amino acids, organic acids and amides. These molecules influence soil nutrient availability both directly and indirectly by stimulating the activities of certain microbial and fungal components of the soil biota.

Microbial Interactions

Are of two types**,** Positive and Negative interactions.

Positive Interactions:

Mutualism: Mutualism defines the relationship in which some reciprocal benefit occurs to both partners. It is a relationship with some degree of obligation. Partners cannot live separately, and are dependent on each other. Examples, Lichens are the association between specific ascomycetes either green algae or cyanobacteria phycobiont**.** The characteristic morphology of given lichen is a property of the mutualistic association and is not exhibited by either symbiont individually. Because the phycobiont is a photoautotroph dependent only on light, carbon dioxide, and certain mineral nutrients, the fungus can get its organic carbon directly from the alga or cyanobacterium. In turn the fungus protects the phycobiont from excess light intensities, provides water and minerals to it, and creates a firm substratum within which the phycobiont can grow protected from environmental stress.

Mutualism – Syntrophism

Syntrophism:It is an association in which the growth of one organism either depends on or is improved by growth factors, nutrients, or substrates provided by another organism growing nearby. Sometimes both organisms' benefit. This type of mutualism is also known as cross- feeding or the satellite phenomenon.

Protocooperation: A positive symbiosis which involves syntrophic relationships. Benefits both organisms are in relationship. It differs from mutualism because cooperative relationship is not an obligatory.

Example, Quorumsensing is a phenomenon where, accumulation of signalling molecules enables a single cell to sense the number of bacteria (cell density).

Commensalism: Commensalism is a relationship in which one symbiont, the commensal, benefits while the other is neither harmed nor helped. Commensal meaning organism that benefits. When the commensal is separated from its host experimentally, it can survive without being provided some factor or factors of host origin. Examples, Intestinal microorganisms: In the human colon, when oxygen is used up by the facultatively anaerobic *E. coli*, obligate anaerobes such as Bacteroides are able to grow in the colon. Formation of biofilms: initial colonizer helps other microorganisms attach. Skin or surface microbes on plants or animals: host plant or animal releases volatile, soluble, and particulate organic compounds used by commensals.

Negative Interactions

Predation: When one organism, the predator, engulfs and digests another organism, the prey, The prey can be larger or smaller than the predator, and this normally results in the death of the prey. Examples: *Bdellovibrio,* a periplasmic predator that penetrates the cell wall and grows outside the plasma membrane, *Vampirococcus* with its unique epibiotic mode of attacking a prey bacterium, *Daptobacter* showing its cytoplasmic location as it attacks a susceptible bacterium.

Parasitism: The population that benefits, the parasite, drives its nutritional requirements from host, which is harmed. It can involve physical maintenance in or on the host. It is characterized by relatively long period of contact.

Competition: Competition arises when different microorganisms within a population or community try to acquire the same resource, whether this is a physical location or a particular limiting nutrient. This principle of competition was studied by E. F. Gause, who in 1934 described this as the competitive exclusion principle (When competition between species results in the elimination of one species from a given habitat or region).

Amensalism: It is relationship in which the product of one organism has negative effect on another organism. Example: The production of antibiotics that can inhibit or kill a susceptible microorganism. Bacteriocins (Proteinaceous toxins produced by bacteria with antimicrobial toxicity.

Summary

The rhizosphere is a microecological zone in direct proximity of plant roots. It is often operationally defined as the soil that clings to roots after being gently shaken in water. The actual extent of the rhizosphere is dependent on the zone of influence of the plant roots and associated microorganisms. This area of soil is considered to be the most biodiverse and dynamic habitat on Earth. Plant roots have strong effects on the physical environment in the rhizosphere. The rhizosphere is an area heavily influenced by microorganisms that feed on the compounds exuded by the roots within the soil. Additionally, displays of symbiotic relationships between plants and microorganisms are shown when plant roots release nutrients such as sugars and amino acids through water soluble compounds that sustain and provide for microbial existence.

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Antioxidant Vitamins: A Newer Approach in Curtailing Pesticide Resistance

Article ID: 12081

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Introduction

Insects expose to numerous toxic substances in the environment starting from secondary metabolites to numerous insecticidal agents. The repeated exposure of insect population to these toxic substances has resulted in the evolution of resistance to different classes of insecticides and many plant based allelochemicals. Scientists all over the globe are working to develop green chemistry pesticides with fewer amounts of residues and novel modes of actions in order to curtail pesticide resistance. However, there is another solution which is conventional but novel in its mechanism *i.e.,* manipulating the dietary composition of insects with antioxidant vitamins. Just like how the food we eat boosts our immune system, insects as well can modulate their immunity by the food they consume. The dietary composition of living organisms has a role in regulation of their physiology and behavior. In this article, we are focusing on how the dietary antioxidant vitamins could regulate genetic mutations which leads to pesticide resistance.

Antioxidant Vitamins and their Functions

Antioxidant vitamins found in insects are A, C, E and Beta-carotene (pro vitamin A). These are hired for scavenging free radicals containing reactive oxygen species (ROS) and consequently it protects the cells from damage caused by ROS-mediated reactions. These antioxidant vitamins perform a crucial role in minimization of oxidative damage to DNA and additionally facilitate in decreasing nucleotide mutation rates.

Mechanism of Antioxidant Vitamins in Pesticide Resistance

The mechanism involved is that, the antioxidant vitamins reduce the number of genetic mutations and also reduces the selection pressure which results in the evolution of pesticide resistance (Huang *et al*., 2020). The antagonism of these vitamins to the toxicity and recovery of insects from the damage caused by insecticides enables them in development of resistance. The extent to which vitamins defend against ROS-mediated mutagenesis and reduce the number of resistant pests is a matter of speculation. Furthermore, in *Drosophila*, vitamin absorption and cellular levels decrease with age, suggesting that vitamin deficiency may be a sign of ageing.

Case Studies

Huang *et al*., 2020 conducted research on the model system of *Drosophila* and revealed that dietary vitamin C intake significantly reduced DDT resistance following multigenerational low-dose DDT selection. They also found that dietary vitamin C had an effect on directional selection, reducing the amount of synonymous and non-synonymous variations in the genome. The larvae of *Plutella xylostella* fed with Vitamin C treated cabbage leaves showed low mortality rates when compared to the control. Vitamin C enhanced and restored the damage done by Chlorpyrifos in *P. xylostella* (Xia *et al*., 2018). Vitamin E is antagonistic to permethrin in both susceptible and resistant insects with the knockdown resistant (kdr) mutation in the voltage gated sodium channel (Scott 1998). These studies reveal that dietary antioxidants may, under some circumstances, impact the evolution of pesticide resistance.

Future Prospects

1. The microbial symbionts provisioning of antioxidants vitamins in insect pest complex may be cut off as a management strategy. Thereby reducing the xenobiotic resistance.
2. Antioxidant vitamins can be employed to activate the Mitogen-activated protein Kinase (MAPK) pathway as in case of *Drosophila melanogaster*.

3. Antioxidant vitamins may be incorporated at adequate concentration for xenobiotic degradation in honeybees and in development of the insecticide resistance. A further study on increase of survival rate in honeybees through these vitamins may be done.
4. In case of honey bees, antioxidant vitamins will activate internal antioxidant enzymes glutathione -S-transferases (GSTs) which are responsible for the breakdown of DDT into non-toxic DDE.

Conclusion

The idea of chemical control was very successful at the beginning but the resistance and ecological backlash made them a significant threat to the environment and its management. So, an emphasis is required for the management of agricultural pests in an eco-friendly manner. Using the cutting-edge technologies available now-a-days, the scientists may use antioxidant vitamins in the dietary composition of insects to tackle the evolving resistance. This may also be achieved through genetically modified insects i.e., by cutting down the provision of microbial symbionts. This will not only attempt at reducing the problem of evolving resistance but also helps in the effective management of vector borne diseases transmitted by insects.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Phytobiotics: A Step Towards Sustainable Aquaculture

Article ID: 12082

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Introduction

With the growing population the demand for animal protein is increasing. Fish being the cheapest source of animal protein is facing challenge to boost the production to meet the growing demand. The increasing demand for fish leads to the intensification of aquaculture industry which in turn produces high stress environment, poor water quality and overcrowding. This in turn generates the chances of numerous infectious diseases to the fish which will lead to the declining production. Previously antibiotics were used to prevent and to treat the infectious aquaculture diseases. But the use of these antibiotics has very harsh impact on the environment as well as on humans. Therefore, alternative have been sought to wipe out the problem and phytobiotics is one of the alternatives.

Phytobiotics in Aquaculture as a Therapeutic

Use of plant products for curing disease and to boost the immunity is an alternative to chemical drugs for disease management in aquaculture. Many biomedicinal plants helps to stimulate the immune response, promote growth, increase appetite, act as antibacterial, antifungal, antiviral and antiparasitic agent in aquaculture. They are a rich source of terpenoids, alkaloids, tannins, saponins, phenolics, steroids and flavonoids which help them to perform the above function. They are an ecofriendly, inexpensive alternative of chemical drugs with minimal side effects. This review helps in understanding the importance of phytobiotics for the sustainable aquaculture production.

Phytobiotics as an Antibacterial Agent

Fishes are much susceptible to bacterial infection which leads to bacterial diseases in fish. Various bioactive compounds like polysaccharide, phenolics, proteoglycans, flavonoids help in preventing the bacterial infection. These phytobiotics perform their antibacterial activity by disrupting the bacterial cell wall, blocking its DNA and protein synthesis, inhibiting their enzyme activity and interfering with the signaling mechanism of quorum sensing pathway. The herbal plants with antibacterial properties are widely studied and applied in aquaculture. The hexane extracts of oarweed and methanolic extract of red hornweed has been found to show strong antibacterial activity against 16 marine and fish pathogenic bacteria. Some authors reported that Garlic extracts inhibit the activity of 2 Gram +ve bacteria, 4 Gram -ve bacteria and 18 isolates of Edwardsiella.

Phytobiotics as an Antiviral Agent

In aquaculture production the viral infection is a serious problem leading to the partial or total loss of production. The outbreak of White spot syndrome virus (WSSV) has annihilated the entire population of shrimp farm within few days. Yellow- Head Virus (YHV), Infectious pancreatic necrosis virus (IPNV) and Infectious haematopoietic necrosis virus (IHNV) are another class of viruses causing high mortality. Several studies have revealed the antiviral property of medicinal plants against several fish viruses. The ethanol extracts of *phyllanthus spp.* shows antiviral activity against YHV. Studies have reported that 18 herbs including *Clinacanthus spp., P.anarus, P.debelis* etc inactive the IHNV, IPNV and *onchorhynchus masau* virus.

Phytobiotics as a Growth Promoter

Faster growth of fishes is the major requirement of aquaculture. Several herbal plants have been found to stimulate the growth of fishes. Phytobiotics helps in increasing digestibility and bioavailability of nutrients which help in feed conversion, protein synthesis and eventually increasing the growth of fishes. The fingerling of Nile tilapia (*Oreochromis niloticus*) shows high growth performance when fed with ginseng herb (Ginsana®G115). Studies show that papaya leaf contain papain, which helps in increasing growth rate, protein digestion, food conversion ratio and gaining weight in *Penaeus monodon* larvae.

Phytobiotics as an Antifungal Agent

Another major problem in aquaculture is fungal infection. Phycobiotics are found to lyse the cell of fungi, alter its permeability, affecting its metabolism and protein synthesis ultimately leading to death of fungi. Extracts of *O. basilicum* and indian almond (*Termanilaia catappa*) shows antifungal activity in tilapia eggs. Studies showed that ethanol extracts of common rue (*Ruta graveoleus*) prevent the growth of saprolegnia.

Phycobiotics as an Immunostimulant

Immunostimulants are naturally occurring substances that stimulates the immune system inhancing the defence mechanism making the fish more resistant to diseases. The *Ocimum sanctum* shows phagocytic activity against Ae*romonas hydrophila* in tilapia culture. Studies shows that extracts of *Tinospora cordifolia* increases the neutrophils activity in organisms. Methanolic extract of *W. somnifera* and *Myristica fragrans* shows immunostimulatory effect against *Vibrio harveyi* infection in groupers (*Epinephalus tauvina*).

Conclusion

Keeping in view the increasing demand for protein, the expansion of aquaculture is necessary which will ultimately lead to intensification. But intensification of aquaculture means the rise of infectious disease that will decline the aquaculture production. Antibiotics are used to minimize the effect of these diseases but it causes another problem like antibiotic resistance and accumulation of chemical in environment or in fish tissue which will affect human health. To overcome this problem photobiotic are the alternative solution. They are the best replacement of antibiotics as will they are cheaper, ecofriendly and have minimal side effects. They are rich in bioactive compounds and perform several pharmacological functions like triggering the growth in fishes, stimulating immunity, antibacterial, antiviral, antifungal activities in aquaculture. Keeping all these things into account it can be concluded that herbal plants will lead aquaculture towards sustainability.

AGRICULTURE & FOOD: E-NEWSLETTER
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E-ISSN: 2581 - 8317

Biosensors: Principle and Applications

Article ID: 12083

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A biosensor is analytical device rely on the intimate coupling of a biological recognition element with a physical transducer to convert the biological signals into a electrical signal or other signals, proportional to the concentration of analytes. The first scientifically proposed as well as successfully commercialized biosensors were electrochemical sensors for multiple analytes.

The following statement is also defined for the biosensor, "A chemical sensing device in which a biologically derived recognition is coupled to a transducer, to allow the quantitative development of some complex biochemical parameter" (Shagun *et al.,* 2017). A basic unit of biosensor includes a receptor, transducer and processor. The sensing elements may be enzymes, antibodies, nucleic acids or whole cells forming a recognition layer that is integrated with transducer *via* immobilization (Kumar *et al.,* 2010). Dr. Leland C Clark, the father of biosensors, established the concept of utilizing a biological sensing element for the detection of different analytes.

Transducers are based upon the parameters of measurement which may be amperometric (current measurement at constant potential), potentiometric (potential measurement at constant current), piezoelectric (measurement of changes in mass), thermal (measurement of changes in temperature) or optical (detect changes in transmission of light) (Kumar *et al*., 2010). Adsorption, encapsulation, matrix entrapment, covalent binding, cross linking are the major immobilization methods used to achieve close contact between bioreceptor and transducer.

Based on biological sensing unit used, biosensors are classified into immunosensor, DNA biosensors and enzyme biosensors (Lazcka *et al.,* 2007). Applications of biosensor techniques are plenty and detection techniques used are ever advancing to suit the purpose of these applications. Biosensors are successfully used for the quantitative estimation of several biologically important substances in body fluids e.g., glucose, cholesterol, urea.

Glucose biosensor is a boon for diabetic patients for regular monitoring of blood glucose. Now a day, biosensors are employed to measure the odour and freshness of foods. For instance, freshness of stored fish can be detected by ATPase. ATP is not found in spoiled fish and this can be detected by using ATPase. One pharmaceutical company has developed immobilized cholesterol oxidase system for measurement of cholesterol concentration in foods (e.g., butter). Biosensors are very helpful to monitor environmental (air, water) pollution. The concentrations of pesticides and the biological oxygen demand (BOD) can be measured by biosensors. Several environmental pollutants can be evaluated for their mutagenicity by employing biosensors (Prabhakaran *et al*., 2017). Biosensors have been developed to detect the toxic gases and other chemical agents used during war.

A microbial biosensor is a biosensor that uses microorganisms which consists of numerous enzymes as the bioelements. The enzymes in the living cells can produce a response to the analytes specifically and selectively, without neither the necessity of time-consuming and costly purification nor the negative effects of the operating environment. In order to transfer the responses from the recognition elements to the transducers, the immobilization between the bioele- ments and the transducers must be intimate and stable. Integrating the microorganisms onto the transducer is the basic requirement of achieving a reliable microbial biosensor.

Microbial biosensors have become one of the most useful means of monitoring environmental, food and clinical samples (Chunhui *et al*., 2013). Biosensors are specific, sensitive, rapid and economical, thus providing a viable alternative to plant pathogen detection methods. However, problems are remained associated with these biosensors are chemical/physical stability of the transducers in the biological samples tested, difficulty in immobilizing biomolecules on transducer surface, poor signal, *etc.* These problems can also overcome in future. Efforts and funds need to be mobilized to manufacture biosensors on a large scale so as to benefit and make to commercially available for plant pathogen detection.

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Bacteriorhodopsin and its Application in Nanotechnology

Article ID: 12084

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Bacteriorhodopsin is a proton pump found in Archaea, it takes light energy and coverts it into chemical energy, ATP, which can be used by the cell for cellular functions. Bacteriorhodopsin forms chains, which contain retinal molecule within; it is the retinal molecule that absorbs a photon from light, it then changes the confirmation of the nearby Bacteriorhodopsin protein, allowing it to act as a proton pump. While chlorophyll-based ATP generation depends on a protein gradient, like bacteriorhodopsin, but with striking differences, suggesting that phototrophy evolved in bacteria and archaea independently of each other.

Bacteriorhodopsin (BR) is a retinal protein molecule found in the photosynthetic system of a salt-marsh bacterium called *Halobacterium salinarium*. In its native form, the BR molecule is located in a cell membrane commonly called the purple membrane (PM). Within the bacterial cell, BR is critical to the survival of the organism in an oxygen-deficient environment, as the BR molecules function as light-driven proton pumps which transport protons across the cell membrane. This generates a proton gradient which in turn produces an electrochemical potential used by the organism to synthesize adenosine triphosphate (ATP). Effectively, BR is used by the bacterium to directly convert sunlight into chemical energy. The absorption of light also initiates a photocycle in the BR molecule which accompanies the transportation of protons. The characteristics and effects of this photocycle make it a potentially useful material for development as an optically sensitive film that is self-developing and erasable. A tremendous advantage of BR's organic nature is that it readily lends itself to genetic engineering, which allows the generation of genetic variants that may possess significantly different optical characteristics.

Biotechnological applications on the basis of the colour change between purple and yellow (long living intermediate M) is the basis for using of bacteriorhodopsin for optical information recording. The technique has advanced such that it could be used as a safety feature on chipcards. Three types of photochromic changes in bacteriorhodopsin have been described which enable different applications. The first is the photochromic shift between the B and M states, and this is used mainly for optical processing tasks. The second is photoerasable data storage using 9-cis-containing states of the blue membrane or suitably modified BR-variants. And last, permanent photochromic changes obtained through two-photon absorption in bacteriorhodopsin are suitable for long-term data storage.

To explore and utilize for development of photonic materials based on bacteriorhodpsin and its mutants for many different applications in optics include – holography, object recognition, interferometry, optical memory, real time information processing, and detection of small vibrations, novelity filters, optical switches and many others. Bacteriorhdopsin is a natural photoelectric generator and each step of the bacteriorhodopsin photocycel is accompanied by generation of a corresponding photocurrent. Several photoelectrical and electro-optical effects include modulation of transistor amplification with ultrahigh speed.

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Magnetotactic Bacteria and their Application

Article ID: 12085

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Magnetotactic bacteria (MTB) are a group of Gram-negative prokaryotes that passively align and actively swim along the geomagnetic field and other fields. This ability is based on specific intracellular structures, the magnetosomes, which, in most MTB, are nanometer-sized, membrane-bound crystals of the magnetic iron minerals magnetite (Fe_3O_4) or greigite (Fe_3S_4) (Lefèvre *et al*. 2011). These intriguing microorganisms were first documented by Salvatore Bellini as early as 1963. He microscopically observed a certain group of bacteria swam toward the Earth's North Pole and hence named them "magnetosensitive bacteria". Eleven years later, independently described these microorganisms and coined the terms magnetotaxis for the phenomena and MTB for the bacteria. The discovery of MTB proved to have a serious impact in a number of diverse research fields including microbiology, geology, mineralogy and biomineralization, crystallography, chemistry, biochemistry, physics, limnology and oceanography, and even astrobiology.

Magnetotactic bacteria (MTB) represent a diverse group of Gram-negative motile, aquatic microorganisms that have the ability to biomineralize intracellular, nano-sized magnetic crystals, called magnetosomes, through a controlled biomineralization process. These organisms were discovered based on their magnetic response in magnetic fields, called magnetotaxis, where cells passively align and swim along magnetic field lines resulting in their accumulation at the edge of water drops in a magnetic field when viewed with a microscope.

MTB are a morphologically, metabolically and phylogenetically diverse group of mostly aquatic, Gram-negative, motile prokaryotes that is ubiquitous in natural aquatic habitats. The term "magnetotactic bacteria" has no true taxonomic meaning as they are distributed widely among a number of different phyla in the domain Bacteria. Magnetosomes are usually arranged in one or more chains within the cell often along the cell's long axis if the cell is not spherical in morphology. The magnetosome membrane surrounding each magnetic crystal is a lipid bilayer that contains numerous proteins, which originates from invaginations of the cytoplasmic membrane of the cell. The vesicle resulting from the pinching off of the membrane is thought to play an important role in creating a chemical/redox environment promoting the nucleation and growth of magnetite and greigite crystals controlling their size and shape.

The advantage of using MTB or magnetosomes for drug delivery is that an applied magnetic field can be used to make the drug reach the specific target in the organism without affecting other, non-targeted tissues. Several years following the discovery and description of MTB and magnetosomes in 1975, many researchers became interested in their potential use(s) in biotechnological and nanotechnological applications because of the magnetic, physical and optical properties of MTB and magnetosomes. Advances in the molecular biology and genetics involved in magnetosome magnetite biomineralization resulted in numerous protocols and DNA recombinant technologies to functionalize magnetosomes, thereby improving their use in biomedicine and bioremediation. In addition, many recent advances in culturing MTB, particularly after 2013, appear to have had a significant impact on the use of magnetosomes in biotechnological applications.

Other areas that need to be investigated are the roles of MTB in heavy metal uptake and metal processing in magnetosome magnetite biomineralization to fully evaluate the potential and impact of MTB in bioremediation. It is now very clear that MTB have not only been shown to have a significant impact in environmental biogeochemistry but also in applied biotechnology, nanotechnology and medicine.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Microencapsulation Techniques

Article ID: 12086

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Microencapsulation is a process of packaging solids, liquids, or gaseous materials as an active material with a continuous film as a coating to form capsules in the micrometer to a millimeter in size (Tyagi *et al.*, 2011).

Microencapsulation techniques are classified into three groups (Tyagi *et al.*, 2011):
1. Physical methods such as spray drying, lyophilization, supercritical fluid precipitation, and solvent evaporation.
2. Physico-chemical methods including coacervation, liposomes, and ionic gelation
3. Chemical methods such as interfacial polymerization and molecular inclusion complexation.

Physical Methods

1. Spray drying: Spray-drying is an encapsulation technique related to the atomization of a liquid into a dry powder using an injector including a hot drying gas stream.

This technique comprises of three stages:

a. homogenization of feed liquid (includes a core and wall material, maybe a solution, an emulsion, or a suspension) by an atomizer.
b. Drying of feed solution by a hot gas carrier to achieve the evaporation of the solvent.
c. Collection of dry particles by cyclones or a filter.

Typical wall materials that have been used for spray drying are polysaccharides such as gum arabic, cyclodextrins, and maltodextrin with different dextrose equivalent values, proteins such as whey proteins, sodium caseinate, soybean proteins, and others including modified starch, gelatine, gellan gum, and chitosan. (Bae *et al.*, 2008).

Limitations:

a. Relatively high drying temperatures can damage sensitive compounds such as lycopene, β - carotene, anthocyanins, vitamin C, colors, and flavors.
b. Low product yield is reported due to loss of dry particles in the wall of the drying vessel
c. The low water solubility of polysaccharides (alginate, carboxymethylcellulose, guar gum) and proteins (whey proteins, soy proteins, sodium caseinate) result in limitations in the practice of spray drying because of the higher water and lower dry matter contents which would need larger evaporation.
d. Carrier agents are needed to process sugar-rich materials because of their low glass transition temperature and stickiness behavior.

2. Lyophilization Freeze-drying: Freeze-drying, also known as lyophilization, is a multi-stage process that consists of:

a. Freezing.
b. Sublimation (primary drying).
c. Desorption (secondary drying).
d. Finally, storage stages, resulting in a dry material.

Freeze drying is the most suitable technique for dehydration of almost all heat-sensitive substances such as **natural oils, colors, aromas, drugs as well as water-soluble components**.

Limitations:

a. High capital and operating costs in comparison to others.

b. The porous structure of freeze-dried powders due to the ice sublimation during the process is also one of the major limitations, the active material within the capsule matrix is exposed to the atmosphere from the pores on the particle surface.

Supercritical Fluids Based Techniques

A supercritical fluid is a solvent at a temperature and pressure above its critical point (Tc, Pc) at which it possesses properties between those of liquids, such as density and high solvating power, and gases, such as low viscosity, high diffusivities as well as high mass transfer rates.

Numerous compounds could be stated at supercritical conditions including carbon dioxide, water, propane, nitrogen, etc., Among these, carbon dioxide (CO_2) is the most commonly used supercritical fluid due to its moderate critical conditions (Tc = 31.1 °C, Pc = 7.38 MPa).

Supercritical fluid-based processes are generally classified into three categories, regarding the role of the supercritical fluid:

1. As a solvent: Rapid Expansion of Supercritical Solutions (RESS): In this process solutes including active compound and polymer are dissolved in a supercritical fluid followed by the expansion of solution using a small nozzle into a lower pressure region. This results in the precipitation of solutes due to a dramatic decrease in the solvent power of supercritical fluids.

2. As an anti-solvent: Supercritical Anti Solvent (SAS) precipitation:

a. SAS process is based on bringing into contact a supercritical fluid, which acts as an antisolvent, with a solution including organic solvent and solutes of interest by injecting into a pressurized chamber through a nozzle

b. In contact with the solution, the supercritical fluid decreases the solubility of the solutes in the atomized particles, leading to their supersaturation, nucleation, and formation of nano- or microparticles.

c. Then, the organic solvent is eliminated from the particles under a continuous flow of supercritical fluid.

As a Solute: Particles from Gas Saturated Solutions (PGSS)

PGSS is a process that includes the saturation of a solute with a supercritical fluid, followed by expansion through an atomization nozzle of this gas-saturated solution causing the formation of solid particles due to the cooling effect that occurred by the release of the supercritical fluid.

Solvent Evaporation

Solvent evaporation is defined as solvent removal from an emulsion consisting of a polymer volatile organic solvent in water.

This technique is based on four major steps:

1. Dissolution of the polymer as coating and active compound in an organic solvent to form a suspension, an emulsion, or a solution.
2. Emulsification of the organic phase (dispersed phase) in an aqueous phase (continuous phase) by stirring, static mixing, extrusion, or dripping.
3. Solvent removal by evaporation or liquid extraction and recovery of particles by filtration or centrifugation and drying of the microspheres.

Physico-Chemical Methods

1. Coacervation: Coacervation technique can be defined as a colloidal phenomenon that involves liquid-liquid phase separation of a single or a mixture of two oppositely charged polymers in aqueous solution triggered by electrostatic interactions, hydrogen bonding, hydrophobic interactions, polarization-induced attractive interactions, chemical or enzymatic cross-linker agents including glutaraldehyde, transglutaminase, etc.

Process:

a. Preparation of an emulsion dispersing a core material into an aqueous polymer solution.

b. Wrapping of this phase as a uniform layer around the core material by adding the second aqueous solution promoted by the addition of salt, changing the pH, temperature, or dilution of the medium.

c. Stabilization of the microcapsules by cross-linking, desolvation, or thermal treatment

d. Soluble, aggregated, or precipitated complexes are obtained after filtration or centrifugation applied to obtain microcapsules
e. Washing with an appropriate solvent and
f. Drying gelatin, alginate, chitosan, glucan, and cellulose derivatives and gelatin/gum arabic, gelatin/carboxymethyl cellulose, alginate/polylysine, alginate/chitosan, albumin/gum arabic, and glucan/cellulose derivatives are the commonly used coating material.

2. Liposomes: Liposomes are vesicles consisting of single or multiple bilayers mainly composed of phospholipids which have both hydrophilic head and hydrophobic tail groups.

Microencapsulation by liposomes has a great inherent potential for encapsulating flavorings, essential oils, amino acids, vitamins, minerals, colorants, enzymes, microorganisms, antioxidants, antimicrobial agents, preservatives, and omega-3-fatty acid.

The unique properties of liposomes are their high bioavailability, biocompatibility, biodegradability, and high cell membrane permeability. (Parhizkar *et al.,* 2018)

Chemical Methods

Interfacial polymerization: In this technique, the capsule shell will be formed at or on the surface of the droplet or particle by polymerization of the reactive monomers. Generally used monomers include multifunctional isocyanates and multifunctional acid chlorides. These will be used either individually or in combination.

Monomer dissolved in the liquid core material and it will be dispersed in an aqueous phase containing dispersing agent. A co-reactant multifunctional amine will be added to the mixture. This results in rapid polymerization at interface and generation of capsule shell takes place.

A polyurea shell will be formed when isocyanate reacts with amine, poly-nylon or polyamide shell will be formed when acid chloride reacts with the amine.

When isocyanate reacts with a hydroxyl-containing monomer it produces a polyurethane shell.

Molecular inclusion: Molecular inclusion is an encapsulation technique that takes place at a molecular level, consisting of entrapment of the guest (active) compound by a host (polymer) through physicochemical forces, such as hydrogen bonding, van der Waals forces, or hydrophobic interactions (Marques, 2010). These complexes are formed through a reaction that takes place only in the presence of water. The most common "host" molecules are cyclodextrins (CDs), which are composed of a hydrophilic external part and an internal hydrophobic part. The guest molecule in apolar character could be entrapped into the apolar internal cavity through hydrophobic interactions.

Factors Influencing Encapsulation Efficiency

1. Solubility of polymer in the organic solvent.
2. Solubility of organic solvent in water.
3. The concentration of the polymer.
4. The ratio of dispersed phase to continuous phase (DP/CP ratio).
5. Rate of solvent removal.
6. The molecular weight of the polymer.

Conclusion

There are different types of microencapsulation techniques that can be used effectively to improve the nutritional and nutraceutical quality of food either by concentrating or fortifying active ingredients.

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E-ISSN: 2581 - 8317

Sea Ranching - A Technique for Boosting the Indian Marine Stock

Article ID: 12087

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Introduction

With the ever-growing human population and rise in the global food consumption there is an increasing demand for seafood all over the world. Fish being a highly nutritious and healthy food commodity, is of great demand. According to UN FAO, ninety percent of the commercial fish stocks are fully exploited and one third of them are harvested at biologically unsustainable levels. The global fish stock that feeds billions of people are dwindling. The need of the hour is to switch on to sustainable fisheries in order meet the growing demand as well as to protect further exploitation of the marine resources. We also have the responsibility to revive the declining stocks of several marine species that are facing the threat of extinction due to overexploitation.

Sea ranching also known as ocean ranching, originated in the USA in around 1870s, is the concept of artificial recruitment of juveniles of marine organisms into their natural habitats. Presently sea ranching is an internationally accepted culture system where the seed or the crop is reared in confined areas, the young ones are then released into their natural environment and finally upon maturity the adults are caught from their natural environment. This concept can be beneficial in marine stock enhancement, conservation of marine resources and in augmenting the production from the marine sector. Usually, species with higher economic importance or whose stock requires replenishment are chosen for this procedure.

Fig: Sea Ranching [Ref: The Hindu]

The Sea Ranching Culture System and Stock Enhancement

Sea ranching, an aquaculture system, that has received increased significance in the last 15 years or so, involves the mass release of juveniles; especially the hatchery produced ones of potential species for certain purposes. The main goal of restocking programmes is to replenish the endangered or nearly extinct species using juveniles produced from the captive brood stocks. In cases where over fishing or poor environmental conditions has led to decrease in the population size of a marine species the mass recruitment of juveniles can increase the population size i.e., sea ranching or may improve the wild recruitment i.e., stock enhancement. Here the fish are attracted repeatedly to a specific location in their natural environment which is called as 'aggregating' or 'herding'. The cue for herding can be acoustics, feeding stations or can even utilise the migratory return of fish as in case of Salmons and the released juveniles are caught from these specific ranching stations itself when they reach the marketable size. The released individuals are usually tagged.

The first international symposium on Stock Enhancement and Sea Ranching (ISSER) was held in Bergen, Norway in the year 1997. The International Conference of Fisheries to Food Securities (held in Kyoto, Japan, 1995) declared stock enhancement as one of the prolific measures **"to promote the use of sustainable and environmentally sound fisheries"** in coastal regions. Responsible stock enhancement through sea ranching should look into several aspects such as biology and behaviour of the candidate species, releasing strategies for juveniles, conservation of natural stocks, evaluation of stock effectiveness and the possible impact on the natural ecosystem.

Unlike the usual culture practises this technique allows the recruited organisms to grow in their own wild habitat i.e., there is no use of confined structures involved. This system involves several activities like brood stock management, induced breeding, nursery rearing of young ones, effective release of the seeds or juveniles, impact assessment on environment and monitoring of the recruited juveniles as well as the natural stock.

Juvenile Quality and Stock Release Strategies

Researches show the chances of improving seed quality which ensures better scope for stock enhancement in future. More studies must be conducted focussing on diverse aspects of sea ranching including rearing techniques, hatchery-release effects, release strategies, effective monitoring system of the released stock, physiological, ecological, behavioural aspects of the stocked juveniles etc.

Studies suggest that by identifying an optimal size of juveniles at the time of release, recovery rate can be increased. A significant increase in recapture was observed with an increase in the size at the time of release as larvae are more viable to predation than juveniles. Human activities such as sport fishing, trawling etc. arise threat as they may catch the juveniles before they mature.

Suitable Candidate Species for Sea Ranching

Not all species are suitable for sea ranching. Success can owe to several factors like biological attributes, ecological interactions etc. of the candidate species, regional variations etc. About thirty fish species in the Pacific Ocean and less than ten species in the Atlantic Ocean are identified as ideal species for future sea ranching. Pacific Salmon is the most successful species till date. Giant clams, European lobster, penaeid prawns, scallops etc. are some potential species in places like China, USA and Europe.

In India, sea ranching of pearl oyster, clams and penaeid prawns started around 1980s. *Holothuria scabra* species of sea cucumber was another candidate species. Spiny lobster whose catch was declining required urgent ranching.

Sea Ranching as a Part of ICZM in India

Sea ranching can be done as a part of Integrated Coastal Zone Management. For instance, in Tamil Nadu Sea ranching was done to replenish the fish stock resources that was depleted due to the oil spill in Pulicat. The fisheries department in association with Rajiv Gandhi Centre for Aquaculture (RGCA) and Central Institute of Brackishwater Aquaculture (CIBA) spent about sixty lakhs on ranching seeds of *Lates calcarifer* (sea bass) and *Fenneropenaeus indicus* (Indian prawn).

About one lakh seeds of Cobia (*Rachycentron canadum),* twenty million seeds of Indian prawn (*Fenneropenaeus indicus)* and eighty million seeds of Black tiger shrimp (*Penaeus monodon)* were released at Thoothukkudi, Ramanadapuram and Nagapattinam districts of Tamil Nadu as a part of the phase II of the integrated coastal zone management. A total of 10.5crore was spent on this project.

Advantages of Sea Ranching

Though this system is considered as impractical by many scientists it has got several advantages. Sea ranching requires lesser inputs as compared to other mariculture practises as enclosing structures are not required here. Feed often accounts for more than 60% percent of total aquaculture production cost however this can be reduced to a large extend as here the organism is free to roam around in its' natural environment. Moreover, it increases the yield for human consumption and also does not affect conventional fishing practices. Some studies states that ranching can also help in reducing bycatch and minimize the catch of undersized fish because of their unique acquisition strategy that is based on aggregating the fish to a particular location. This can be helpful in reducing harmful fishing techniques. Experiments in cod fish conducted in Iceland showed that sea ranching is more profitable than full-cycle farming.

Challenges to Sea Ranching

Hatchery-born juveniles may fail to adapt to the local environment. Also, there are chances for genetic drift as there is significant difference in the population size of cultured stocks and wild stocks; this can lead to genetic variability. The process may also lead to inbreed depression. Therefore, the release of monosex population or sterile ones has been recommended by researchers as this may ensure interspecific hybridization or sex reversal. Conditioning of juveniles before the release can be beneficial to a certain extend. The size of the stocking population must be suitable for the carrying capacity of the natural environment. Advancements in hatchery technology helps in producing healthy juveniles. Increased poaching in farmed areas can be another issue as ownership issues may arise. The possible impact the exotic population may cause to the local ecosystem is also a major cause for concern. Steps must be taken to prevent the transfer diseases from the cultured stock to wild stock. Toxic elements or poor water quality parameters in the environment can adversely affect the hatchery-born juveniles.

Conclusion

Global fish consumption increased significantly from 12.4 % of total animal protein consumed in 2009 to 17% in 2017 (SOFIA 2020). UN FAO has predicted that the global per capita fish consumption would reach 21.5 kilograms in 2030. With the responsibility to sustainably feed the world's people and to reduce the burden on the oceans 'Sea Ranching' could be a frontier for expansion. Sea ranching can also help in replenishing exacerbated stocks of at least some species.

Though this technique is not considered a huge success and may not be suitable for many species or some aquatic ecosystems, there are several documentations of successful implementations in many parts of the world. However, it is to be noted that most of these culture practises are still in experimental stages. Scientists should look into diverse aspects of sea ranching such as healthy seed production, release strategies, ecological interactions, impact of recruited stock on natural stock etc. Development of associated infrastructural facilities like hatcheries, rearing units, transport facilities, stock monitoring devices etc. are necessary for the expansion of sea ranching.

AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

A Most Versatile Forest Tree Species - *Bombax ceiba Linn*

Article ID: 12088

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Introduction

Bombax ceiba L. of the family *Bombacaceae* is an important medicinal plant of tropical and subtropical India commonly known as Semal or Silk Cotton Tree. It is the tall deciduous tree, with straight buttressed trunk and broad spreading branches. Almost every part of this plant is used as medicine and its roots and flowers are used for curing the maximum number of ailments. Medicinal usages of *Bombax ceiba* has been reported in many traditional systems of medicine such as Ayurveda, Siddha and Unani medicine since ancient times. Besides having immense medicinal potential, it has also been used for other commercial and industrial purposes.

Habitat & Distribution

Bombax ceiba is widely found in temperate Asia, tropical Asia, Africa and Australia. In India, it can be found at altitudes upto1500 m. In peninsular India, the tree is very commonly seen in the dry and moist deciduous forests and also near rivers. This tree is a great light-demander and fast-growing tree. *Bombax ceiba* grows best on deep sandy loams or other well-drained soils, especially in valleys, in the regions that are receiving 50 to 460 cm annual rainfall well distributed throughout the year.

Common Name

It is known by different names such as Red Silk Cotton tree, Indian Kapok tree (English), Shalmali (Sanskrit), Semal (Hindi), Shimul (Bengali), Mullilavu (Malyalam), Kondaburuga (Telgu) in different languages.

Taxonomical Classification

Kingdom:	Plantae
Division:	Magnioliophyta
Class:	Magniolipsida
Order:	Malvales
Family:	Bombacaceae
Genus:	*Bombax*
Species:	*ceiba.*

Morphology

Semal is a lofty, deciduous tree up to 40 m tall with horizontally spreading branches and young stems covered with hard prickles. Bark is grey brown or silver-grey colored with hard sharp conicles prickles. Leaves are large, spreading, glabrous, leaflets lanceolate, 3-7 and margin entire. Flowers are red numerous, appearing when the tree is bare of leaves, stamens many arranged in five bundles of 9-12 each and an inner bundle of 15. The fruits are brown capsule-like up to 15 mm long, filled with numerous black seeds. Seeds are smooth, black or grey embedded in long white wool, which are irregular obovoid in shape, smooth and oily with dense silky hair. Gum is light brown to opaque or dark brown called as semul gum.

Uses

B. ceiba, one of the important plant species is used in various indigenous systems of medicine in India, China and Southeast Asian countries. Almost every part of the plant is used as medicine and its roots and flowers are used for curing maximum number of ailments. Its young roots are roasted in the fire and eaten like roasted sweet potato while some tribes eat even raw roots during famine or otherwise also. The roots of *B. ceiba* are cooling, sweet, stimulant, tonic and demulcent and are used in dysentery. The gum has the property of cooling, aphrodisiac, astringent, and demulcent. The bark has the property of demulcent and emetic, and it also has the power of healing. Leaves are used for skin eruptions. Flowers are used as an astringent and are good for skin troubles, splenomegaly and hemorrhoids. Seeds are said to be useful in treating gonorrhea and chronic cystitis.

B. ceiba is also used for various commercial purposes. It is an important multipurpose tree used for agroforestry, providing food, fodder, fuel and fiber. Due to high protein content in the leaves, the plant is the most preferred fodder species. It is widely used in silvipastoral system of agroforestry, to meet the feed requirements of livestock during the fodder deficit period in winter. Wood of this plant is strong, elastic and durable which is best suited for ship, boat and catamaran building. It is most widely used in match industry and for planking ceilings, canoes, shingles, toys, scabbards, coffins, well curbs, brush-handles and artifact production. Oil isolated from its seeds is comparable to true Kapok plant and can be used as an edible oil substitute for cottonseed oil, for soap making and as an illuminant. Floss isolated from its fruits is an excellent material for making padded surgical dressings, insulating material for refrigerators, soundproof covers and walls and as being vermin-proof; it is most suitable for making cushions, pillows and upholstery. The plant is best matchwood resource and useful for reclamation of wastelands and my spoils. So, it can also be used to improve the barren soil and gain the economic benefits.

Conclusion

Bombax ceiba is a very valuable tree; its each and every part is useful for various purposes. It is considered as one of the most valuable trees as ethnomedicinal and commercial purpose. This article may develop awareness among people regarding importance and valuable uses of this tree. It is one of the most important tree species that has economic and ecological importance and should be conserved for ecological perspectives.

AGRICULTURE & FOOD: E-NEWSLETTER
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E-ISSN: 2581 - 8317

Co-composting of Municipal Solid Waste with Additives: An Approach for Safer Disposal of Solid Waste

Article ID: 12089

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Abstract

Municipal solid waste compost (MSWC) production from municipal solid waste provides a better solution for safer disposal under solid waste management strategies. The relatively safer and stabilized/matured MSWC has been used successfully as soil amendments in agricultural lands for crop production as a source of nutrients and organic matter addition. On the other hand, trace metal content builds up in soil were also reported in certain cases which may pose threat to soil health and ecosystem service. The co-composting of municipal solid waste with a specific bulking agent can improve particle structure and density, and provide airspace required to enhance the aerobic bacterial activity thus hastening the rate of degradation. The co-composting materials like biochar, zeolite and lime are believed to reduce the heavy metal bioavailability in soil and its mobility to plants.

Keywords: Municipal solid waste compost, co-compost, additives; plant nutrients, heavy metals.

Introduction

Improvement in living standards coupled with increasing population, speedy industrialization and unintended urbanization has led to tremendous increase in the amounts of municipal solid waste generation every year in India. Majority of the city solid waste generated in India were disposed through landfills and open dumps which creates health issues to soil, plant, animal and human being. Dumping the municipal solid waste in landfills accounts to about nearly 70% of the total collected municipal solid wastes and as a result it poses a greater threat to soil degradation, air pollution through greenhouse gas (GHG) emissions and public health (Ghosh et al., 2018). Among the various existing methods of solid waste recycling (waste to energy, incineration, gasification etc), composting has found to be a better option for safer disposal of waste without deteriorating natural resources and ecosystem service. The relatively safer and stabilized/matured MSWC has been used successfully as soil amendments in agricultural lands for crop production as a source of nutrients and organic matter addition. Also, the compost from MSW addition to agricultural soil as manure may also introduce some heavy metals to the soil system that are subject to bioaccumulation/biotransfer and may cause risk to human health when transferred to the food chain.

Quality of Municipal Solid Waste Compost

The composted municipal solid waste has several advantages like volume reduction (40-50%) for easy disposal, absence of harmful pathogens for safer disposal, and enriched quality compost with better maturity index along with loaded plant nutrients and organic matter content for soil amendments. Inspite of the above stated advantage, the major obstacle in the recycling of MSW composts is the presence of significant amount of toxic heavy metals (He et al. 1992). In India, the heavy metal content in the 86% of MSW composts studied was found to have more than the permissible limits (Saha et al., 2010). During composting process, the heavy metal content remains unaltered due to its not biodegradable nature and changes being unaffected during microbial respiration.

In generally, the municipal solid waste compost has higher potentially trace metal concentration and greater availability in the smaller sized particle of municipal solid waste compost in comparison to larger sized particle (Saha et al., 2013). Saha et al. (2013) conducted to investigate physico-chemical properties, fertilizing potential and heavy metal polluting potentials of municipal solid waste composts produced in 29 cities of the country. The result indicated that municipal solid waste compost prepared from biogenic wastes of segregated source had higher organic matter, total nitrogen and total phosphorus to an extent of 57, 77 and 78%, respectively as compared to compost prepared from biogenic waste of non-segregated source. The trace metal concentration was also significantly lower to an extent of 63, 78, 64, 84, 50 and 63% for Zn, Cu, Cd, Pb, Ni and Cr, respectively as compared to compost prepared from biogenic waste of non-segregated source/mixed waste.

MSWC Applications on Trace Metal Build Up in Soil

Several authors have reported changes in physico-chemical properties of soil and enhanced plant growth with the application of MSWC. MSWC application to agricultural soils has several advantages like improving soil fertility, improving soil structures, water holding capacity and soil biological health. On the contrary, application of MSWC also raises concern on trace and heavy metals build up in soil under long term period (Madrid et al., 2007). The presence of trace and heavy metals will eventually restrict its application to soil, because of loading possibility of contaminants in soil that could negatively affect soil health and could pose a long-term environmental hazard. Several published literatures also stated that the total and extractable soil concentrations of trace metals increased when soil was amended with MSW compost. A study conducted by Yuksel (2015) indicates that MSWC application at the rate of 10 t ha^{-1} under long term may create a heavy metal risk and deterioration in soil health. Coumar et al. (2021) observerd that soil amended with MSWC showed significant increase in heavy metal mobility (DTPA-extractable content) in soil and its subsequent transfer to leafy vegetable (transfer coefficient). Cuevas et al. (2000) had reported that concentrations trace metals were significantly higher in the MSWC amended soil as compared to control (unamended soil).

Co-Composting of MSW with Additives

The presence of trace metals in the composted MSW can contribute a long-term environmental hazard following the application of MSWC as metals have very long residence times in soils. The metals present in the compost are mobilized through the soil fractions once the compost is introduced in the soil. To overcome the above-mentioned negative impacts of MSW compost, many ways have been found so that the benefits of the same are harnessed to the fullest. Among the possible methods of waste utilization, mixing of different raw materials during the process of composting, which is known as co-composting, is regarded as the most economical way for the treatment and final disposal of solid waste (Yousefi et al. 2012). If co-composting is done with a specific bulking agent, it can improve particle structure and density, and provide airspace required to enhance the aerobic bacterial activity thus hastening the rate of degradation. The co-composting materials most preferred are biochar, zeolite and lime which are believed to reduce the heavy metal bioavailability in soil and hence uptake by plants. Previously studies have been done that the quality of the final co- composted product improves with the use of additive materials like biochar in the composting process (Gondek et al. 2018; Sanchez-Monedero et al. 2018). Awasthi et al. (2018) found that compost modification with 10% zeolite and 1% lime is economically feasible practice for co-composting of biosolids. Stylianou et al. (2008) also observed that the presence of metals during composting processes in the exchangeable form may increase by the breakdown of organic matter, in which they can be re-adsorbed and immobilize by zeolites through ion exchange mechanism during co-composting process. Coumar et al. (2021) reported that the application of co-composted MSW with biochar (MSWBC) resulted in the reduction of heavy metal content of spinach leaves and roots compared to municipal solid waste compost (MSWC) amended soil. Addition of co-composted MSW with biochar (MSWBC) resulted in reduction in spinach leaf of Cu, Cd, Pb, Cr, Ni, and Zn to an extent of 20.6, 28.9, 36.0, 41.9, 41.5, and 41.2%, respectively.

Conclusion

Municipal solid waste compost addition improves soil fertility, biological health and crop productivity due to presence of plant nutrients and organic matter in the compost. On the other hand, trace metal content builds up in soil were also reported in certain cases which may pose threat to soil health and ecosystem service. Co-composting of MSW with various additives like biochar, zeolite, lime and other organic and inorganic materials improves the compost quality; and its subsequent addition to soil as soil amendments improves soil fertility and reduces trace metal mobility the soil to the plant system.

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E-ISSN: 2581 - 8317

Apomixis: A Boon for Plant Breeders

Article ID: 12090

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Summary

Apomixis is an asexual seed formation method, where seeds are formed without the union of male and female gametes – the production of cloned seeds. It is a natural phenomenon where the plant simply bypasses the most fundamental basis of sexual reproduction, to form viable seeds. In nature, apomixis is widespread but infrequent and has been reported in more than 400 species, where it is believed to be controlled by a single dominant locus responsible for the entire developmental process. Apomictic breeding is widely considered as a next generation breeding technology which is likely to revolutionize the agricultural sector and food production, as it would reduce the breeding times and costs associated with conventional practices. Similar to genetic engineering, apomixis also possess the ability to demolish some of the species' barriers that have delimited the evolution of our crop plants over the course of time. Moreover, with the advent of advanced techniques like synthetic apomixis in the recent years, the future of plant breeding looks quite promising.

Introduction

Sexuality is a well-established feature in all seed producing plants. In angiosperms, the most common pattern of reproduction is double fertilization, where two male gametes combine with an egg cell and a central cell giving rise to a diploid embryo and a triploid endosperm, respectively. By contrast, formation of seeds also occurs in apomictic plants, but without any fertilization and the seed formed will have a genotype that is consistent with the female parent. Apomixis was first discovered by Leuwenhock in Citrus seeds in the early 18th century. Commonly referred to as the "holy grail of plant biology", apomixis can be divided into three types: apospory, diplospory and adventive embryony (Koltunow, 1993). Among these, apospory and diplospory comes under gametophytic apomixis as they are derived from unreduced embryo sacs, while adventive embryony/ sporophytic apomixis arises from somatic cells of the ovule.

Although occasionally alluded to as a 'botanical curiosity', in nature apomixis is far from rare and is relatively prevalent among angiosperms, showcasing a unique distribution pattern which suggests that it has evolved multiple times. It has been reported in more than 400 species belonging to 40 families and is known to occur more frequently within families like Asteraceae, Poaceae, Rosaceae and Compositae. Only a handful of crops like citrus, mango and some tropical forages are found to be naturally apomictic while maize, wheat and pearl millet are reported to have apomictic wild relatives. As far as agriculture is concerned, apomixis holds the potential to ultimately transform plant breeding by enabling new and improved varieties to retain their unique and valuable traits through asexual reproduction. Hence, introducing apomixis into crops would allow selection of individual plants and their propagation as clones through their seeds. It would also help to expand the range of wild relatives of crop plants that could be integrated into various crop improvement programmes.

Genetics and Inheritance of Apomixis

The unique positioning of different apomictic species and the presence of varied apomictic mechanisms within the multiple angiosperm families suggest that apomixis has evolved independently multiple times. Also, earlier studies show that it is inherited as a dominant trait i.e., apomixis is controlled by a single dominant locus. In most species, apomictic loci exhibit a suppressed recombination and genetic analyses searching for rare recombinants in these suppressed regions revealed that the developmental components of apomixis are controlled by independent loci. For e.g., Noyes and Rieseberg (2000) has reported that diplospory and parthenogenesis in Erigeron and Taraxacum species is controlled by two independent loci.

This deviation of recombination frequency at apomictic locus suggests a strong divergence of alleles at the apomixis-related genomic regions. In extreme cases like Hieracium, Pennisetum and Paspalum, this divergence is associated with hemizygosity of the associated loci while, some other apomictic loci is also found to be associated with heterochromatic and/or substantial repetitive sequences. In nature, most apomicts are polyploids, and earlier it was proposed that apomixis is a product of hybridization and genome doubling. But later, studies emphasized the fact that polyploidization alone is not enough to cause apomixis and not all polyploids are apomicts.

Apomixis – A Next Generation Breeding Technology

Apomictic breeding is an emerging breeding technology which is capable of revolutionizing the agricultural crop production. Here the current research is focused on two main fronts i.e., to identify and characterize genes that are responsible for apomixis in apomictic species and to switch or engineer the normal sexual reproduction pathway in non-apomictic species, to one that mimics apomixis. Normally, hybridization is followed for introducing apomixis in both self- and cross-pollinated sexual crops Mostly, for any breeding programme, the sources of genes for apomixis include cultivated species of crop plants, wild species of cultivated crop plants, related genera of crop plant and mutants. Usually, the introduction of apomixis into sexual species follows three main approaches:

Conventional wide-cross transfer from an apomictic relative – this method is practiced when the wild relatives of the concerned species are available. Here the apomict is used as a male parent and crossed with the female sexual parent; resulting F1 hybrid is backcrossed with the sexual parent followed by selection of the apomictic derivatives. This method is quite often exploited in maize, pearl millet and wheat.

Induced mutations – done in order to change the sexual seed formation pathway into an apomictic one by altering the function of the vital genes involved in the sexual process. Ravi *et al.* (2008) reported that in Arabidopsis, mutation in one sexual gene - DYAD/SWITCH1 *(SWI1)*- can lead to the avoidance of meiosis in female gamete formation process and hence produce unreduced gamete.

Molecular biology and genetic engineering approaches - for the past few years, molecular marker technologies and molecular biology approaches have provided new insights into the identification and characterization of candidate genes responsible for apomixis in many plants. Several markers co-segregating with apomixis has been reported in grasses like *Pennisetum, Brachiaria, Paspalum* and hybrid maize-*Tripsacum*. Molecular studies revealed the presence of an apospory specific genomic region (ASGR) in *Pennisetum squamulatum* which was not present in sexual individuals. Gene expression studies along with other procedures like transposon tagging, mutagenesis and fine mapping around apo-locus are currently being developed and these could play important roles in identifying apomixis related genes in the future.

Synthetic Apomixis

Naturally apomixis have the capacity to retain hybrid vigor for a number of generations in economically important plants. The knowledge regarding the genetics and evolution of asexual seed production is still hazy and hence, more efforts are needed to find its genetic architecture. Under such circumstances, researchers have proposed synthetic apomixis as an alternative to fix hybrid vigor. This can be done either through *MiMe* strategy or through genome editing. The development of *MiMe* (mitosis instead of meiosis) genotypes is further used for the production of clonal gametes. Genome modifications involving genome editing technologies has also been successfully deployed in synthetic apomixis. Induction of haploid plants from egg cells was achieved in rice by either triple knockout of the *Baby Boom* (*BBM*) genes or the disruption of the expression of genes specific to egg cell *MATRILINEAL* (*MTL*) using CRISPR/Cas9 gene-editing technology (Khanday *et. al.,* 2019).

Conclusion

Apomixis is likely to be one of the most cherished dreams of any plant breeder in years to come. It is a highly complex developmental mechanism expected to have a huge impact in plant breeding if introduced into economically important crops, shortening the time and cost required to develop new and improved varieties. Although eclipsed for a long time, the mechanisms underlying the origin, dynamics and evolution of apomixis in natural populations, and its ultimate utility in plant breeding is being slowly disentangled. Apomixis when combined with plant genomics can work wonders by quickly delivering uniform crops better tailored to end-product uses, be it food, feed, fiber, pharmaceuticals or any raw materials. The capability of apomixis to create and stabilize new genetic combinations and disrupt species barriers could possibly lead to an "asexual revolution", which could even dwarf the green revolution.

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E-ISSN: 2581 - 8317

Climate Smart Agriculture: Current Worldwide Progress

Article ID: 12091

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Addressing climate change and transforming agri-food systems are key to meeting the Sustainable Development Goals (SDGs). Nearly 690 million people around the world face hunger today (FAO, 2020) while agri-food systems emit one third of global anthropogenic GHG emissions (Crippa *et al*., 2021) and there is a growing public demand for climate action. Therefore, it is important to achieve food security through adaptation and mitigation of climate change. Climate risk management is an approach implemented throughout the world, by all types of stakeholders. The concept of climate risk management is achieved through an integrated approach commonly referred to as climate smart agriculture. There are five points created for successfully implementing climate risk management approach that is climate smart agriculture viz. 1) expanding the evidence base for climate smart agriculture, 2) supporting enabling policy frameworks, 3) strengthening national and local institutions, 4) enhancing funding and financing options, and 5) implementing climate smart agriculture practices at field level. These action points have three basic principles/pillers viz. sustainably increasing agricultural productivity and incomes, adapting and building resilience of people and agri-food systems to climate change, and reducing and/or removing greenhouse gas emissions where possible. This approach of mitigating/adapting to current and upcoming climate risks also fits in FAO's sustainable agriculture agenda.

Expanding the Evidence Base for Climate Smart Agriculture

In the first point steps that can possibly be taken are (i) improving remote-sensing monitoring capabilities, (ii) including CSA in national agricultural extension services, (iii) developing agroclimatic information systems and (iv) monitoring soil fertility. In Sri Lanka recently a project named "Save and grow" was launched for building of the evidence base for CSA through the assessment of future climate change impacts on six main crops i.e., rice, maize, green gram, onion, chilli and potato (Table 1).

Table. 1: Outcomes of save and grow project in Sri Lanka:

Outcomes	Optimised production	Climate change adaptation	Climate change mitigation
According to the rice research and development institute, farmers cut back total irrigation requirements for rice cultivation per season by 10-20 percent by adopting new water management practices. This allowed them to store water for the next cropping season. All farmers of the Meegassegama reservoir-initiated land preparation early (at the beginning of rainy season), instead of waiting for water reservoirs to fill and irrigation water to be released from reservoir	yes	yes	
Farmers were able to expand land under irrigation by 15 percent during the dry season. This expansion was made possible by the training received by farmers in the alternate wetting and drying technique, which allows them to save water during the main growing season	yes	yes	

The community experienced the highest water capacity ever recorded at the end of dry season. The combination of practices such as early planting, the use of rainwater (instead of irrigation water) and the alternate wetting and drying technique allowed this change	yes	yes	
By using soil testing kits and leaf colour charts and by applying fertilizer to parachute trays, farmers were able to apply fertilizer more precisely, thus reducing the amount of fertilizer used by 27 percent	yes	yes	yes

Supporting Enabling Policy Frameworks

With respect to this action point FAO recommended to design policies strive to overcome economic, social and gender related barriers in overcoming impact of climate change on agriculture by involving all stakeholders including, locals, private and government. Government plays a prime role in enabling policy frameworks for the implementation of CSA in which different stakeholders work. A sound understanding of priorities of stakeholders involved in CSA is required to build a successful policy framework.

The study undertaken by Institute of Bio Economy (IBE Italy) aimed to assess to what extent the investments made by the region of Emilia-Romagna (Italy) helped local stakeholders promote and adopt CSA practices. In the first step of the study, eight types of climate change threats viz, “soil deterioration”, “water scarcity”, “deteriorated water quality”, “shifts in vegetative seasons”, “spread of pests”, “diseases”, “extreme weather events” and increases in “GHG emissions” due to intensive livestock management practices were observed. A notable example is the project entitled “*Irrigation system optimization in fruit farming for adaptation to climate change*”.

The Department of Agricultural and Food Sciences of the University of Bologna, IBE and “Consortium for the Emiliano Romagnolo Channel” carried out this project jointly in a commercial pear and apple orchard in Medelana (Ferrara province). The aim of the project was to devise a sustainable irrigation system that conserves water and cools the system in the orchards. These types of solutions are needed in the wake of climate change induced temperature hike. The two-year study revealed that a sustainable irrigation system can cool the plant canopy by 4^{o}C.

Strengthening National and Local Institutions

Local and national institutions play an important role in support and empowerment of farmers to implement CSA practices. Local and national institutions engage with policy makers by sharing knowledge and ground reality that also helps a nation globally in fight against climate change. From 2015 to 2019, the Rainforest Alliance implemented a project to promote the adoption of CSA practices by cocoa farmers in the world’s leading producer countries, including Ghana. The project was implemented in collaboration with CIAT, Root Capital and the Sustainable Food Lab, and funded by CCAFS. The goal of the project was to adopt more climate resilient cocoa cultivation strategies to improve cocoa productivity and withstand present and future climate threats. Using existing value chain interventions, the project translated climate science into actionable strategies for farmers, processors, certifiers and investors. Science-based training materials focusing on the climate risks faced in specific cocoa-growing regions in and around five natural reserves in Ghana’s Sui River landscape were produced (GIZ, 2018). These climate-smart manuals are being used by lead farmers in the Sui River landscape, which helps them prioritize and tailor CSA practices to their particular locations and build resilience at farm level (ESC, 2019). These manuals are being shared with members of world cocoa foundation. For example, the Hershey Company has, in collaboration with Farmerline, developed a smart phone application called “Cocoa Link”; that can be used to access CSA training manuals based on an interactive risk map (Economic commission for carribean and latin America, 2016). In March 2017, the Ghanaian Government and dozens of cocoa companies adhered to the Cocoa and Forests Initiative, which aims to end deforestation in the cocoa supply chain. Conserving forests is part and parcel of building climate resilience, as forests not only absorb the emissions that contribute to climate change but also provide crucial ecosystem services.

Enhancing Funding and Financing Options

It includes linking climate funds and financing to public and private agricultural investments in innovative ways; and integrating climate change considerations and CSA in agricultural strategies, plans and budgets, as well as in rural development programmes and projects. Intergovernmental, governmental and private sector entities provide financial resources for the development and implementation of CSA policies and strategies. Links between climate and agriculture funding and financing are important. Strong monitoring and evaluation is required for adequate reporting on the benefits of adaptation and mitigation efforts. Importantly, government investment in CSA may serve as a catalyst for private sector investment; it may thus lead to the wider scaling up of CSA practices and therefore to greater and sustainable agricultural productivity, increased resilience and capability to adapt to climate change, and the reduction and/or removal of GHG emissions. Sustainable Rice Landscapes Initiative (SRLI), launched in 2018 by the World Business Council for Sustainable Development (WBCSD), the Sustainable Rice Platform (SRP), FAO, the United Nations Environmental Programme (UNEP), the International Rice Research Institute and the German agency for international cooperation or Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). This collaboration initiative brings together diverse stakeholders to promote sustainable rice production practices, with the overall aim of delivering a range of local and global environmental benefits and contributing towards the achievement of the SDGs via multi stakeholder action (FAO, 2021). SRLI aims to attract resources, mainstream best practices and innovative technologies, and connect farmers to markets by collaborating with the national governments of rice-growing countries in South East Asia and South Asia. GEF projects supported by SRLI or projects with an SRLI-related component are now being developed in nine countries in Asia. Over USD 60 million in GEF resources and roughly USD 800 million in co-financing from the public and private sectors are dedicated to these projects. The projects bring together public and private sector organizations operating at national and regional levels to improve consumers' recognition of sustainable rice, and thus boost its demand. According to the Sustainable Rice Landscapes Consortium's partner statement of intent, the adoption by smallholders of sustainable, climate-smart best practices may generate the following benefits: healthier watersheds and biodiversity protection; farm and landscape resilience; increased efficiency of water and fertilizer use; lower GHG emissions from rice production; reduced agrochemical pollution; improved farmer health and livelihoods; and strengthened consumer markets for sustainably produced rice (Sustainable Rice Landscapes Consortium, 2019).

Implementing Practices at Field Level

The selection and implementation of CSA practices should be based on solid stakeholder consultations to ensure an engaged process in which valuable knowledge and networks are included. Local knowledge and priorities should form part of the evidence base used for the selection of CSA practices. Indeed, local knowledge on the environment, agro-ecosystems, crops and livestock, forests, fish and local climatic patterns is often a very valuable source of information when choosing the best CSA practices. It is important to engage farmers, pastoralists, foresters and fishers, as well as local project managers and institutions, throughout the selection and implementation process. The project Sustainable Management of Mountainous Forest and Land Resources under Climate Change Conditions, financed by the GEF, is being implemented in Kyrgyzstan since September 2014. This project is executed by the Government of Kyrgyzstan through the State Agency for Environmental Protection and Forestry and the Ministry of Agriculture, Water and Regional Development, with support from FAO. The objective of the project is to contribute to the sustainable management of mountainous agro-sylvo-pastoral ecosystems in Kyrgyzstan and improve their productivity, and thereby improve mountain livelihoods. The main components of the project include the improvement of the legal and institutional framework on forestry and land management, the reforestation and natural regeneration of 8000 ha of forests and the improvement of the management of 20000 ha of land, the promotion and demonstration of CSA and the dissemination of CSA and other knowledge and best practices. The project introduced innovative practices for forest rehabilitation and sustainable forest management in five pilot oblasts and 12 rayons, raised awareness and improved capacities in the State Agency for Environmental Protection and Forestry on the global climate change benefits of calculating and monitoring carbon sequestration and reducing GHG emissions through forest rehabilitation and sustainable management. The project strengthened the capacities of associations of users of local resources (forests, pastures, water) for the management of forest areas, and improved collaboration between them. The project also assisted in the assessment of the country's existing forest policy (including the National Forest Programme 2011–2015) and the development of a new national "Forest Concept" for the period until 2040. The main activity undertaken by the project to achieve these results is the preparation of a manual that describes interesting innovative SLM technologies and practices based *inter alia* on the World Overview of Conservation Approaches and Technologies. These technologies and practices include practices that help preserve agricultural (IRRI, 2016) biodiversity (for example, the reduction of arable land, crop rotation, crop residue management and the use of vegetation covers), the use of biofertilizers on degraded land, the implementation of life cycle management in organic agricultural systems, integrated land restoration to increase soil fertility in the face of climate change, modern water conservation systems for irrigation, composting by small farmers, etc. Demonstration plots for selected technologies will be created in the fields of both male and female-headed farming households in each of the 12 districts.

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Bottlenecks in Popularity of GM Crops in India

Article ID: 12092

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Genetically modified crops are nothing new globally but their popularity barring cotton is meager in India. The adoption of cotton GMs was rather smooth in India but for other crops skepticism and slow trials took a toll against their release recommendation and adoption. Currently about 10% of global arable land is under GM cultivation in 28 countries. Soyabean, Corn and cotton are major GM crops cultivated around the world.

Apart from this potato (USA), alfalfa (USA), squash/pumpkins (USA), aubergine (Bangladesh), suagrbeet (USA and Canada), papaya (USA and China) and oilseed rape (4 countries) are also cultivated worldwide. India has about 12 mha of area under GM cultivation (Royal society, 2021). Most of these crops are used as feed for animals across Americas and Europe but tomato, papaya aubergine etc are consumed directly.

No human health concerns have been proven or observed across these nations. Then why India is so skeptical about their consumption? Why there are zero GM crops under cultivation India except cotton. In this article, we intend to decipher the bottlenecks to Indian GM revolution.

Well, upon looking at the possible reasons against GM adoption are political will, vested business interests and NGO interference. We say so because Genetic engineering appraisal committee (GEAC) in 2007 after considering trials and tests data had already given green signal to go ahead with release of GM brinjal varieties developed by Mahyco but in 2010 Govt blocked the release of the same giving arbitrary reason of all those concerns which were already quashed by results from the trials and subsequent GEAC approval (Pandey, 2021).

Many denser brains have opined that, GM crops are a threat to biodiversity nut that is a nil point because 20% of cropped area would still remain under a traditional variety in the same field similar to GM cotton. Also, GM genes can be transferred to several local genetic backgrounds and may remain isogenic to local varieties.

Bangladesh has a large area under Bt brinjal cultivation and as of 2018, 27012 farmers cultivate Bt brinjal in Bangladesh. According to a 2020 study conducted by Bangladesh and US scientists, Bt brinjal raised yield by 51 percent and lowered pesticide costs by 37.5% and also estimated 128% revenue enhancement for the farmers (Pandey, 2021).

A study conducted by ICAR-NAIP (2011) noted that even at 15% adoption level, Bt brinjal would enhance national yields by 37% and reduce insecticide by 42%. Apart from brinjal, GM mustard variety DMH-11 (herbicide tolerant) was developed in Delhi University, which is also on hold. Another concern which was put forth by the government was that, the trial terms and regulatory measures are not yet ratified for consumer GM crops in India.

Therefore, a supreme court appointed panel recommended to put all trials on hold and ordered suspension for 10 years. But in 2014, 1 acre of trails were allowed by the government of India and GEAC subsequently approved field trials of 11 GM crops including rice, maize, sorghum, wheat and groundnut.

Another 21 varieties of these crops were approved for trials the same year. In 2016, GEAC also gave approval for GM mustard trials but Supreme Court put that on hold. There are about 20 GM crops at various stages of trials (George, 2020).

From the above discussed points, it can be easily inferred that the only major bottleneck to GM success in India is not the efficiency of scientific community but ability of Government to take swift measures and decisions to ratify trial terms and regulations regarding ethics, fairplay in trials business and cultivation models of concerning GM crops.

The snail pace of the process and roadblocks reflect that many in regulatory powers and business arena unfortunately consider GM crops as a political or whatever risk they think it is. In fact, this should have been left to bio and agriculture scientific community to decide and come up with fair results.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Impact of COVID-19 on Agriculture and Allied Sector in India

Article ID: 12093

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The novel Corona virus (COVID-19) pandemic has rapidly spread across the world, adversely affecting the lives and livelihoods of millions across the globe. India reported its first infection on 30 January 2020, prompting the authorities to soon initiate various measures to contain the spread of the epidemic. Given that the disease is highly contagious, the much-needed nation-wide lockdown was enforced starting 25 March 2020 in order to contain the spread of COVID-19 pandemic. During the initial few weeks, the restrictions were strict and all non-essential activities and businesses, including retail establishments, educational institutions, places of religious worship, across the country were prohibited from operating. The agricultural & allied sector carries immense importance for the Indian economy. It contributes nearly one-sixth to the Indian national income and provides employment to nearly 50% of the workforce. It is fundamental for ensuring food security of the nation and also influences the growth of secondary and tertiary sector of the economy through its forward and backward linkages. The economic implications of the novel Corona virus (COVID-19) pandemic have brought the agricultural sector into sharp focus and heightened its responsibility to feed and employ thousands who might have lost livelihoods. At this time when most sectors of the economy are reported to be under significant stress, the agricultural sector continues to be promising and cushioning the economy. The area sown under all major kharif crops is expected to be higher than corresponding period during the last year. Since the agricultural sector continues to be one of the bright spots amidst this pandemic, there is a need of prioritizing agricultural sector during this time to ensure speedy economic recovery of the country.

The impact of COVID-19 and subsequent lockdown imposed in the entire country owing to COVID-19 on the overall production levels in the agricultural and allied sector has been significant with overall production levels in the agriculture and allied sector declining in 47% of the sample districts studied under a report by NABARD during first COVID wave of 2020. However, 19% of the districts reported an increase in the overall level of production in the sector and 34% of the districts shown no change in the levels of production in the agriculture and the allied sector (Fig. 1A). Impacts of COVID-19 on agriculture are the put off in sowing andharvesting of plants due to the unavailability of merchandisealong with seeds, tractors, ancillary assist, plant protection chemicals, closure of supply chain due to lockdown, shutting down of agri-exports, shutting down of MSME/SME sector and weak consumption of goods because public and institutions started expanse-cutting and saving money due to looming uncertainty (Sahoo and Samal, 2020). Some of the reasons for decline in agricultural activities include lack of availability of labour and machines, need for social distancing, and restrictions on free movement of men and machineries.However, several Govt schemes such as PM-KISAN helped to offset severe damage to affected farmers (Varshney *et al.*, 2020).Subsectors or allied sectors also underwent a decline in overall production nationally and across states (Fig.1B)(Table.1).

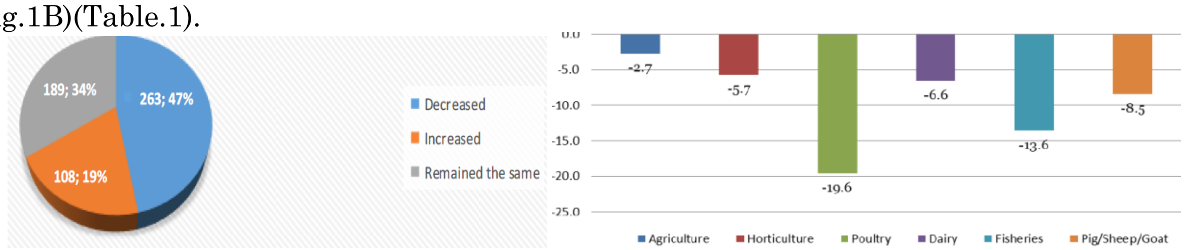

Fig. 1: Number of districts showing change in overall agricultural production (A) with percent decline in production in agri and allied sector (B).
Source: NABARD, 2020.

E-ISSN: 2581 - 8317

Infact all the allied sectors were severely hit by COVID pandemic, but major decline in poultry industry may be attributed to misinformation regarding contraction of COVID-19 through broiler birds.

Table.1 Statewise Magnitude of change in agricultural production:

Status	Sectors					
Increase	Agriculture	Horticulture	Poultry	Dairy	Fisheries	Pig/Sheep/Goat
	Telangana (23 % increase), Punjab (5%), Rajasthan (4.4%) & Gujarat (6.7%	Gujarat (5%), Rajasthan (2.5%) and Karnataka (1.7%)	Arunachal Pradesh 25%	Overall 6.6% decline nationally	Telangana (increase of 7%)	Telangana and Arunachal Pradesh 10% and 25%, respectively
Decrease	Chhattisgarh (13%), Himachal Pradesh (15%)	All states(Himachal, Chattisgarh & TN most affected)	All states (Haryana, MP UP most affected)	Most affected (11.9%), Jharkhand (13%)and Chhattisgarh (11.5%)	All states	Rest of the states Nagaland (25%), Haryana (17%) and Madhya Pradesh (16.3%) reporting the highest decline.

Source. NBARD 2020

Prices of Agricultural Commodities

Overall, the prices of agriculture commodities increased during COVID pandemic but some districts and states showed decline in prices partly due to non-mobility of stock elsewhere. Below figures and tables elucidate impact of COVID on prices of agriculture and allied commodities. (Fig.2).

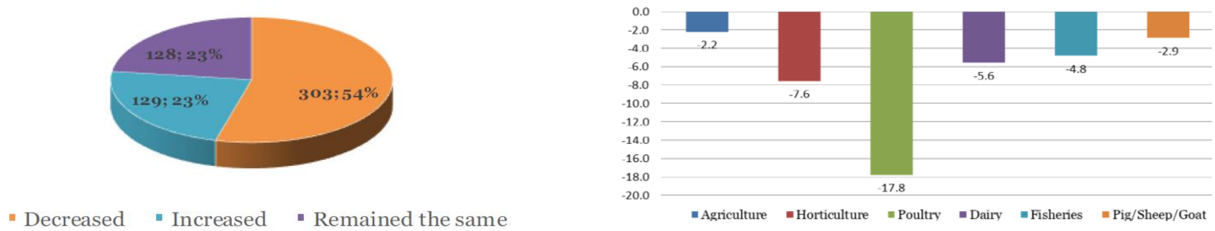

Fig. 2. Number of districts showing change in overall prices of Agricultural commodities (A) and decline in farm gate prices of agri and allied commodities (B). Source: NABARD. 2020.

Availability and Prices of Agri-Inputs

Due to COVID pandemic and subsequent lockdown movement of agri-inputs suffered substantially across all states in India (Sahoo and Samal, 2020). Table 2. and Fig. 3. illustrate state wise, availability and prices of agri inputs in India during 2020.

Table.2: State wise Change in Prices of Agriculture and Allied Commodities:

Status	Sectors					
Increase	Agriculture	Horticulture	Poultry	Dairy	Fisheries	Pig/Sheep/Goat
	Arunachal Pradesh (15%), Mizoram (13.6%), HP (8%) and J& K (7%)	Arunachal Pradesh (15%), Kerala (13%) and Mizoram (10.7%)	-	Arunachal Pradesh 25%), Mizoram (7.5%) and Meghalaya (6.7%)	Kerala (24.15%), Goa (15%) and Tripura (17.5%)	Nagaland (25%), Kerala (16.1%), Tamil Nadu (10.6%) and Telangana (10%)
Decrease	Karnataka (15%),	Karnataka (23%), TN	Most affected	WB (13.8%), Uttarakhand	Punjab (21.7%),	Haryana (21%), Madhya Pradesh

	Telangana (11.7%) and WB (9.7%)	(15.8%), Telangana (15%) and MP (13.3%)	Haryana (37.2%), MP (34.2%), Bihar (31.9%) and Punjab (28.2%)	(15.0%), Jharkhand (14.2%) and Chhattisgarh (11.9%)	MP (19.8%), Haryana (19.3%) and UP (10.7%)	(18.6%), Himachal Pradesh (15%) and Punjab (14.4%)

Source: NABARD, 2020

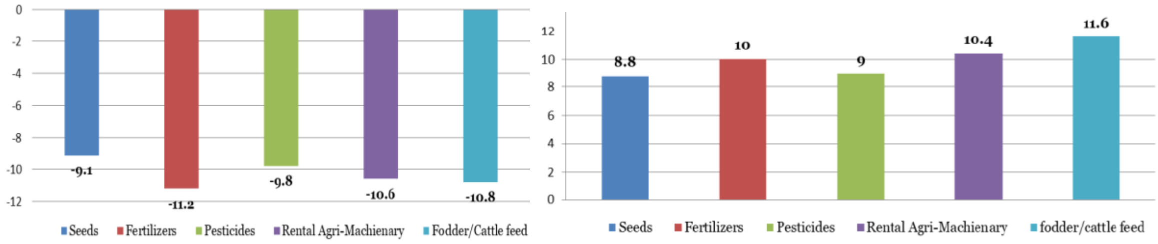

Fig. 3. Magnitude of decrease in availability of agri-inputs(A) and increase in prices of agri-inputs (B).
Source: NABARD, 2020.

Conclusion

Overall, at the national level the impact of COVID-19 and the resultant lockdown had been quite harsh on agriculture and allied sector in majority of districts. Among various subsectors, rabi crops were least affected as its harvesting was on the verge of completion but allied sectors such as poultry, fisheries and pig/goat/sheep sector witnessed a drastic fall in demand due to misplaced rumors leading to declining production as well as declining farm gate prices. However, prices of agriculture inputs were estimated to be rising mainly due to disruption in supply chain and closure of shops and markets. Although banking activities were exempted from lockdown, yet basic banking services viz. loans, deposit and recovery were severely hampered in majority of the sample districts in the country. However, the positive aspect was the increase in digital banking transactions in majority of the country. The microfinance sector and MSME sector was the biggest casualty with disruption in more than four-fifths of the districts surveyed by NABARD thereby seriously hampering the livelihood in the unorganized sector which provides maximum employment in the rural areas. The activities of FPOs and FCs also came to complete halt. However, these rural institutions including SHGs grabbed the opportunities provided by the situation of stitching facemasks, PPEs and preparation of sanitizers thereby helping the society as also earning some income for their members. Further, FPOs in close coordination with local administration in some of the districts were quite instrumental in door-to-door delivery of fruits, vegetable and dry rations to the needy there by extending a helping hand to the society. These rural institutions like SHGs and FCs were also active in creation of awareness in rural areas about COVID 19 and its preventive measures.

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Crop Modeling with Special Emphasis on Rice Crop Models

Article ID: 12094

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Introduction

Crop models are tools of systems research which help in solving problems related to crop production. Modeling is the use of equations or sets of equations to represent the behaviour of a system. In effect crop models are computer programmes that mimic the growth and development of crops. Model simulates or imitates the behaviour of a real crop by predicting the growth of its components such as leaves, roots, stems and grains. Thus, a crop growth simulation model not only predicts the final state of crop production or harvestable yield, but also contains quantitative information about major processes involved in the growth and development of the crop. Reactions and interactions at the level of tissues and organs are combined to form a picture of the crop's growth processes.

Crop modeling has become important tool in modern agricultural research. So far different models and methods have been employed in attempts to assess the impacts of climate change on rice production, such as crop production models, yield prediction and quantities of water or fertilizer consumed. To help resource poor farmers in the tropics and sub tropics IBSNAT (International Benchmark Sites Network for Agrotechnology Transfer) began the development of a model in 1982. IBSNAT was an attempt to demonstrate the effectiveness of understanding options through systems analysis and simulation for ultimate benefit of farm households across the globe. The major product of IBSNAT was the Decision Support System for Agro- Technology Transfer (DSSAT) which is currently being used as a research and teaching tool. As a research tool its role is to derive recommendations concerning crop management and to investigate environmental and sustainability issues. The DSSAT products enable users to match the biological requirements of crops to the physical characteristics of land to provide them with management options for improved land use planning. The package consists of: data base management system for soil, weather, genetic coefficients, and management inputs, Crop simulation models, series of utility and weather generation programs and strategy evaluation program to evaluate options including choice of variety, planting date, plant population density, row spacing, soil type, irrigation, fertilizer application, initial conditions on yields, water stress in the vegetative or reproductive stages of development, and net returns.

Input Data Requirement

Crop modeling requires data related to weather, crop, soil, management practices, insect-pests and diseases.

1. Weather data includes: Maximum and minimum temperature, rainfall, relative humidity, solar radiation and wind speed. Weather data is required at daily time step to assess daily crop growth processes.

2. Crop data includes: Crop name, variety name, crop phenology (days to anthesis, days to maturity etc.), leaf area index, grain yield above ground biomass, 1000-grain weight.

3. Soil data includes: Thickness of soil layer, pH, EC, N, P, K. soil organic carbon, soil texture, sand and clay percent, soil moisture, saturation, field capacity and wilting point of soil, bulk density.

4. Crop management data includes: Date of sowing of crop is required to initiate the simulation process. Generally sowing data is taken as the start time for the simulation. In case of transplanted rice date of transplanting is used instead of sowing date. Seed rate and depth of seeding are also required. Use of inputs in the crop field, namely irrigation, fertilizer, manure, crop residue etc. needs to be mentioned.

5. Insect-pests data includes: Name and type of the pest, their mode of attack, pest population at different crop growth stages. Data on insects or pests are included only in those models which contain the pest module.

6. Disease's data includes: Name and type of diseases. Data on diseases are included only in those models which contain the disease module.

Model Parameterization (Calibration, Evaluation and Validation)

Model calibration involves the modification of some model parameters such that data simulated by the error free model fit the observed data. In many instances, even if a model is based on observed data, simulated values do not exactly comply with the observed data and minor adjustments have to be made for some parameters. Noncompliance may arise from sampling errors as well as from incomplete knowledge of the system. Alternatively, it may arise when the model is used in a situation that is markedly different from the one under which it was developed. The model validation stage involves the confirmation that the calibrated model closely represents the real situation. The procedure consists of a comparison of simulated output and observed data that have not been previously used in the calibration stage. However, validation of all the components is not possible due to lack of detailed datasets and the option of validating only the determinant ones are adopted. For example, in a soil water crop model, it is important to validate the extractable water and leaf area components since biomass accumulated is heavily dependent on these. Evapotranspiration also becomes a determinant to validate.

Brief Description of Some Models which are Used in Rice Crop

1. Ricemod: It was developed at the IRRI by MCMennamy (1980) as a rice crop growth and yield simulation model to assess the completeness of knowledge about rice science. The components of this model include timings of plant growth initiation and harvest, maximum leaf area index, harvest index and radiation use efficiency. This model depends on soil, plant and atmospheric data derived from experiments at the IRRI. Photosynthesis, growth and maintenance respiration, partitioning of assimilates to different growth organs and the soil water balance are four soil-plant atmosphere processes in this model (Rao and Rees, 1992). Calibration and validation of RICEMOD was done for high yielding rice variety IR-36 by MC Mennamy and O' Toole, 1983 in the phillipines.

2. Ceres-Rice: Crop estimation through resource and environmental synsthesis-Rice (CERES-RICE) is a generic and dynamic simulation model which was developed under the International Benchmark for Agro-technology Transfer (IBSNAT) project (Ritchie et al; 1987). It is a part of DSSAT. All the DSSAT models are continuously being refined, calibrated, validated and applied by the scientists and their collaborators developed the models. CERES-RICE was designed to estimate yield as constrained for alternative technology and new growing sites, by different characteristics, soil water and nitrogen. It is able to reduce time and cost of agrotechnology transfer of new varieties and management (Bachelet and Gray, 1993). It can estimate the potential yield by combining the properties of crops, weather and soil (Wikarmpapraharn and Kositsakulchai, 2010). The inputs required to run the model are weather variables (daily solar radiation, maximum and minimum temperatures and precipitation), management information (plant population, plant genetics, planting, harvesting dates, row spacing and fertilizer application amounts and dates) and environmental factors (soil type, saturated hydraulic conductivity, drained upper and lower limits etc.) and it is assumed that the crop is well protected against insects, weeds and diseases.

3. Ricesys: It is an ecosystem model for predicting the inter-species and herbivores competition between rice and weeds which provides an applicable tool for integrated pest management studies. It is a useful model to explain the dynamics of rice growth and development and to represent the effect of delays in transplanting date and planting density on growth and yield of rice plant. The model was designed to stimulate growth and development of the rice variety Makalioko 34 from Madagascar under irrigated condition but other rice varieties in other localities can also be simulated through simple parameter changes.

Use of Rice Crop Models

1. Forecasting rice productivity under different ecosystems with variable management practices.
2. Finding the optimum productivity of the genotype in different rice growing environments with the resources available.
3. Improving crop management by finding out best sowing dates, management practices for achieving optimum productivity of rice crop in the particular region.
4. Estimating pest/disease incidence levels and yield loss caused due to this pest incidence and recommend control measures for different situations faced by the farmers.
5. Improving research by analyzing rice yield trends and yield gaps.

Limitations

1. Models require large amount of input data, which may not available with the user.
2. Skilled manpower.
3. Knowledge of computers and computer language.
4. Limited awareness and acceptance towards modeling.
5. Multidisciplinary knowledge.

Conclusion

Rice crop models are holistic, knowledge-based global tools and helps us in assimilating knowledge gained from experimentation. It increases the efficiency of agricultural research and management and also improves agronomic efficiency and environmental quality. An intensely calibrated and evaluated model can be used to effectively conduct research that would in the end save time and money and significantly contribute to developing sustainable agriculture that meets the world's needs for food.

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Integrated Farming System: An Approach to Enhance Farmers Income

Article ID: 12095

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Integrated Farming System

Integrated farming system (IFS) means combining or integrating agriculture and livestock or livestock and fishery or all three. It is often referred to as integrated bio system/s. The components of integrated biosystem or IFS support each other thus reducing the external inputs.

For example, the livestock can provide manure for crops and crops inturn provide fodder/feed for livestock. Farm animals also control weeds by grazing. A very good example of a successful integrated farming system is the CIPAV system, developed by the Foundation Centre for the Investigation in Sustainable Systems of Agricultural Production. In this system local natural resources are utilized to produce several commodities and it exemplifies success of integration. Several systems like, fodder crops, cereals, sugarcane with livestock (sheep, pig, fish and ducks) are taken in an integrated and orderly manner in the same field. Each component in CIPAV sustains each other and minimizes the need for external inputs. Crop provides fodder to livestock and wastes from the livestock and fish serve as fertiliser to the crops. The crop and livestock waste together can also be used as a fuel for kitchen using a bio digester. Farm wastage is reduced and is utilized in best possible way to sustain and make the entire system self-sufficient but not perpetual. The system also reduces its dependence on fossil fuels as farm wastage is used in production of fuel and electricity. Combining of fish culture with livestock and normal agri farming is the most luceraticve. The fishes can be fed with the residuary materials of farms such as branches stacks and stubble. Additionally, the plankton on which all major fish feed can grow using the manures provided by the livestock. Pupae and other wastes from the silk worm raised near the fish farm can then be used to feed the fish. In return the fish pond silt provides an excellent manure and fertilizer for land crops which is very desirable and nutritious to plants. This way integrated farming has multicultural approach which is environment friendly and sustainably provides the economic means to prosper.

IFS imitate the natural principles of coexistence, interdependence and mutual beneficism. *The basic principle is to enhance the ecological diversity:*
1. IFS chooses such systems where there is minimum competition between different components for natural resources and space.
2. It targets to use field area in such a way that there is minimum loss of space and interaction between biotic and abiotic components is optimum.
3. Interacting subsystems are used which help in increased productivity.

IFS is a sustainable system achieved through diversification resource integration and market linkages. Thousands of small and marginal family farmers in resource-poor regions in Asia and Africa have converted their farming to this sustainable farming system to diversify farm production, increase cash income, and improve the quality and quantity of food produced and the exploitation of unutilized resources. Reents and Kainz, (2008) proposed that nearly 4 years are required to develop a self-sustaining IFS with efficient resource integration and market linkages.

Benefits Provided by Using an Integrated Farming System are

1. It changes farming approach towards cropping patterns and optimism utilization of resources for increased economic output and ecological balance
2. Farm waste is recycled to increase productivity with minimum external inputs.
3. A judicious mix of agricultural enterprises like dairy, poultry, piggery, fishery, sericulture etc. suited to the given agro-climatic conditions and socio-economic status of the farmers can bring prosperity to the farming operations.

Many farmers and even entire countries throughout the world are adopting the integrated farming system which use practices that consider the present and future climatic conditions, soil characteristics, the food habits of the population and food security of the ever increasing human and animal population.

The new integrated practices include improved farming technologies like integrated nutrient management, site-specific nutrient management, conservation technology, use of bio-fertilizers, crop rotation, zero tillage, and the use of farm management systems like Agrivi which helps farmers track their activities on fields, as well as the whole farm productivity and profitability. Agrivi also supports farmers with integrated farming by providing them with a knowledge base of the best practice processes in the form of required tasks that allow them to plan the season in advance (Rahman, 2018).

Conclusion

In its real sense, it will help in uplifting the agri-economy and standard of living of the farmers of the country holistically. All stakeholders viz, private companies, Government, universities, KVKs and public sector research stations should make continuous efforts to enhance farmer capacities for adoption of productive, remunerative, eco-friendly and self-sustaining integrated farming systems.

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System of Rice Intensification (SRI)

Article ID: 12096

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Introduction

The System of Rice Intensification (SRI) is a farming methodology aimed at increasing the yield of rice produced in farming. It is a low-water, labor-intensive method that uses younger seedlings singly spaced and typically hand weeded with special tools. It was developed in 1983 by the French Jesuit Father Henri de Laulanié in Madagascar.

Madagascar in the 1980‟s in an effort to find sustainable agricultural practices which lead to higher productivity, optimum use of capital and labour, less input cost and less requirement of water. System of rice intensification (SRI) is an acronym that is defined a system for rice intensification‟. The System of Rice Intensification (SRI) is a way of harmonizing the elements of soil, water, light and plant to allow the plant to achieve its fullest potential, which is often hidden when inappropriate techniques are used. SRI, as opposed to traditional rice production, involves alternate wetting and drying (AWD) of rice fields Research and demonstration plots in several tropical countries have shown SRI techniques as productive resource-saving and environmentally benign when compared to conventional or traditional rice production (Sato and Uphoff, 2007). In the broadcasting, one has to use a minimum of 100kg of rice seeds for one hectare, in planting one required about 30-60kg of seeds or so. But in SRI, only 4-10kg of seeds are required for one hectare. Therefore, this reduces input cost for the farmers and also less drudgery.

SRI Principles

SRI methodology is based on four main principles that interact with each other:
1. Early, quick and healthy plant establishment.
2. Reduced plant density.
3. Improved soil conditions through enrichment with organic matter.
4. Reduced and controlled water application.

Based on these *principles*, farmers can adapt recommended SRI *practices* to respond to their agroecological and socioeconomic conditions. Adaptations are often undertaken to accommodate changing weather patterns, soil conditions, labor availability, water control, access to organic inputs, and the decision whether to practice fully organic agriculture or not.

The SRI Methodology

SRI is a unique innovation in that the productivity of four factors of production-land, labour, capital and water can be increased at the same time, not requiring trade-offs. The first thing to stress is that SRI is a combination of practices (a) that need to be used with appropriate adaptation to local conditions, and (b) that have synergistic effect on one another. The extent and mechanisms of such synergy have not been well studied, so what is reported here comes mostly from observation, though there are some thesis research projects that have given some precise and systematic measurements, which support what has been observed. The basic strategy with SRI is to create soil, water and nutrient conditions favourable for the growth of young plants. There are three dramatic observable and measurable effect: There is much greater root growth. A test of root resistance, which is a proxy for measuring total root development (Toole and Soemartono, 1981) found that it took more than 5 times as much force (53 kg) to uproot a single SRI rice plant as to pull up a clump of three rice plants conventionally grown (28 kg) (Joelibarison, 1998). There is much greater tillering, with SRI plants having 30, 50, even 80 or 100 or more tillers, compared to the more common number of 5 to 10 tillers. Why rice plants have so many tillers with SRI management methods can be explained by the physiology of rice, like other grain producing members of the poaceae (grass) family, in terms of phyllochrons. These are intervals of plant vegetative growth discovered in the 1920s and 1930s by a Japanese researcher (Katayama, 1951). With SRI methods we find a reversal of the relationship between number of tillers per plant and number of grains per panicle (fertile tiller). This has been previously reported in the literature to be negative (Khush and Peng, 1996). But with massive root growth, rice plants become "open systems" and contravene the law of diminishing returns. With SRI grown plants, the relationship observed (now in three different analyses) is positive, reversing the sign previously observed. This is what makes possible going from 2 Mt/ha to 8 Mt/ha.

Reported Benefits of SRI

1. Increase in yield/ha – 52% (21 to 105%).
2. Increased net income/ha – 128% (59 – 412%).
3. Reduction in cost of production – 24% (7 – 56%).
4. Reduction in water requirement – 44% (24 – 60%)
5. Shorter time to maturity (1-3 weeks less).
6. Protection against biotic stresses pests/diseases (Sheath blight, leaf folder, brown plant hopper) – 70% reduction in incidence.
7. Tolerant to abiotic stresses - drought, storm damage, extreme temperatures.
8. Higher milling outturn (by ~ 15%) – lower chalkiness.

The Relation of SRI and Increase in Grain Yield of Rice

There are evidences that cultivation of rice through system of rice intensification (SRI) can increase rice yields by two to three-fold compared to current yield levels (Uphoff, 2007). Husain et al. (2004) documented a 30% yield advantage for SRI in Bangladesh and Namara et al. (2003) showed an even larger benefit of 44% in Sri Lanka. Increased grain yield under SRI is mainly due to the synergistic effect of modification in the cultivation practices such as use of young and single seedlings per hill, limited irrigation, and frequent loosening of the top soil to stimulate aerobic soil conditions (Stoop et al., 2002). Further, combination of plant, soil, water and nutrient management practices followed in SRI increased the root growth, along with increase in productive tillers, grain filling and higher grain weight that ultimately resulted in maximum grain yield (Uphoff, 2001).

Conclusion

System of rice intensification is one of the best practices of improving rice productions with low input and maximum output (yield). It also maximizes the system of production, land labour and capital. I therefore recommend the system to be adopted by both peasant and large-scale rice farmers in order to be self-sustainable and to boost productions to meet the increasing demand of the populace.

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WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Insect Migration, its Pattern, Phases and Types of Migration

Article ID: 12097

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Introduction

Migration is the movement of large numbers of a species from one place to another, usually leaving none behind. Well-known example includes locust swarms. Migration refers to movements of animals in a direction and for a distance over which they have control, and which result in a temporary or permanent change of habitat (Williams, 1957).

Insects are cold-blooded organisms, with bodies that are roughly the same temperature as the surrounding environment. As a result, the insect's major physiological functions are heavily influenced by the external environment. The single most important environmental element influencing insect behavior, dispersion, development, survival, and reproduction is probably temperature.

The most common method for predicting insect life stages is to use accumulated degree days from a base temperature. The effect of temperature on insects largely overwhelms the effects of other environmental factors (Bale *et al.,* 2002).

Characteristics of Migration

The organism undertaking migration is undistracted and it doesn't respond to food or mates, otherwise so necessary a part of life functions. Every species has particular migration behaviors during commencement and termination of migration, such as going to the top of a shrub or tree branch to scratch off on migratory flights, which they do not do at any other time.

Wind-borne migration in insects belonging to the orders Hemiptera, orthoptera, and lepidoptera has been widely researched. Because the wind speed is lower at night, vertical air movement is minimal, and the planetary bound layer is stable, nocturnal insects have a greater potential for wind-borne migration than diurnal insects. (Drake and Farrow, 1988).

Patterns of Migration

Large variation between different organisms the general pattern is that the fundamental niche of the species includes two different types of habitats, each of which is favorable at different times.
1. Daily movements.
2. Seasonal movements.

Some seasonal movements involve very long distances. In the northern hemisphere we know a spring movement north, where there is abundant food in summer, and an autumn movement south, where there is abundant food after the rainy season. Another way to classify migration patterns is to look at how often a person can make the journey.

1. One way only: These migrate in one direction, but never come back. Butterflies like the red admiral and painted lady are most familiar. Individuals fly here from the Mediterranean in summer, breed and die.

Example: Butterflies like the red admiral and painted lady are most familiar.

2. One return journey: These species are born in one habitat, migrate to another, then return to breed and die in the habitat where they were born. Example: Cockchafers (*Melolontha melolontha*),

3. Multiple return journey: Insects travel from their breeding areas to places where they hibernate or aestivate. The lives of these insects include a diapause, or period of dormancy during which development is suspended. Example: Convergent Ladybug (*Hippodamia convergens*), monarch butterfly (*Danaus plexippus*).

E-ISSN: 2581 - 8317

	
Convergent Ladybug (Hippodamia convergent)	**Monarch Butterfly (Danaus plexippus)**

Different Phases of Migration

However, using fast air currents, many species can travel enormous distances (hundreds or even thousands of kilometers), often in just a few days, and the consequences of these large-scale invisible movements of insects can be very noticeable anywhere finish. Some migrations of insects are very remarkable; Among the most impressive natural phenomena are the massive migrations in large contiguous flocks of a few species (for example, the desert locust Schistocerca gregaria, the dragonfly Aeshna bonariensis and the monarch butterfly (Danaus plexippus), which are migratory birds and mammals. (Holland *et al*., 2006). the narrow layer of the atmosphere closest to the ground within which their airspeed exceeds the wind speed (Taylor 1974), Migration can be divided into a four major steps (Milner-Gulland *et al*., 2011).

1. Preparation
2. Departure
3. on the way
4. Termination

	
Dragonfly (Aeshna spp.)	**Desert locust (Schistocerca gregaria)**

Preparation

Exceptions to this general pattern exist in longer-lived species such as the monarch butterfly *Danaus plexippus*, which builds up substantial fuel reserves byforaging as adults, and tops these reserves up during intermittent stopover episodes. The juvenile hormone and its esterase mediate a range of correlated factors associated with migration, e.g., timing of reproductive maturation, fuel deposition, development of larger wings and wing-muscles, and increased flight capability.

Departure

Many insect migrants will not take off when wind speeds at ground level are too fast (more than a few m/s), as they cannot control their flight direction immediately after take-off (e.g., green lacewings *Chrysoperla carnea*, Chapman *et al*., 2006).

On the Way

There is considerable evidence that many high-altitude migrants are capable of aligning their headings in a more-or-less downwind and given that winds blow in favourable directions, displacement distances will be considerably longer than if the insects flew across or against the wind (Wood *et al*. 2006). Chapman *et al*. (2008) have demonstrated that high-flying migrants, hundreds of metres above their FBL, can also influence their displacement direction even though wind speeds far exceed their own air speed. The moth *Autographa gamma* is able to select flight headings that partially compensate for crosswind drift away from its preferred seasonal migration directions, thus maximizing the distance travelled while influencing its migration direction in a seasonally-advantageous manner.

Termination

These include depletion of fuel reserves, changes in photoperiod (e.g., nocturnal insects rarely migrate into daytime, and diurnal species rarely carry on into night-time and changes in temperature (e.g. migrations of nocturnal insects are often terminated due to a drop in temperature as the night progresses (Wood *et al*., 2006).

Types of Migration

1. Seasonal migration: Migration that occurs with the change of seasons. Monarch butterflies in eastern North America migrate seasonally.
2. Reproductive migration: Migration to or from a separate breeding location. Salt marsh mosquitoes migrate from their breeding grounds after emergence as adults.
3. Irruptive migration: Migration that occurs unpredictably, and may not involve the entire population. Painted lady butterflies are irruptive migrants. Their migration is often associated with El Niño weather patterns.
4. Nomadic migration: Migration that involves progressive movement away from the home range, but not to a specific alternate location. Locust migration tends to be Lnomadic.

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E-ISSN: 2581 - 8317

Mechanism of Phosphate Solubilization

Article ID: 12098

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Introduction

It is the second major plant nutrient next to Nitrogen. Total Phosphorous content in Indian soil ranges from 100-2000 ppm. The concentration of soluble P in soil is very low (1 ppm or <1ppm) (Goldstein, 1994). Total P content in agriculture crops 0.1 - 0.5%. Plants absorb in the form of H_3PO_4, $H_2PO_4^-$, $HPO_4^{2-}$and PO_4^{3-} . It has an important role in plant metabolism activities. It exists as both organic and inorganic form. 75% of applied phosphate fertilizer may become unavailable - mineral phase reprecipitation (Sundara *et al*., 2002).

Influence of Phosphorus on Plants

Phosphorus enhances the development of lateral and fibrous rootlets. Results in flowering, fruiting, including seed formation. Strength of straw in cereal crops - prevent lodging. Crop quality (forages and of vegetables).

Factors Affecting Phosphorus Fixation in Soil

Over liming, clay minerals, type of clay, hydrous metal oxides of iron and aluminium, calcium carbonate, soil PH, organic matter and temperature.

Phosphate Solubilizing Microorganism

P-solubilizating ability of the microorganisms is considered to be one of the most important traits associated with plant phosphate nutrition. They have been introduced as phosphate Biofertilizers. They have attracted the attention of agriculturists as soil inoculums to improve the plant growth and yield.

Insoluble phosphatic compound $\longrightarrow$ **Soluble/Available form**

(TCP, RP, bone meal, basic slag and chemically fixed soil P) ($H_2PO_4^-$, HPO_4^{2-} and PO_4^{3-})

Efficient P solubilizing bacteria belongs to the genera *Bacillus*. Some of P solubilizing bacteria includes *Pseudomonas striata, Arthrobacter sp., Acidothiobacillicus ferrooxidans, Bacillus substillis, Bacillus megaterium, Burkholderia polymyxa*. Dominant P solubilizing fungi belongs to *Aspergillus sp*. Some of P solubilizing fungi includes, *Aspergillus niger, Penicillium sp., Aspergillus fumigates, Aspergillus melleus, Aspergillus clavatus, Aspergillus awamori, Trichoderma viride*. P solubilizing actinomycetes includes Actinomycetes - *Actinomyces, Streptomyces. Anabena sp., Calothrix braunii, Nostoc sp., Scytonema sp*. are P solubilizing Cyanobacteria.

Importance of PSM

Increases yield up to 70%. It gives better uptake of P and enhances the plant growth and development. Plays a key role in soil P dynamics and enhances subsequent availability of phosphate. Reduce P fertilizer application by 50% without any significant reduction of crop yield. PSMs can be added with low grade phosphates, slag or bone meal and improve P use efficiency of crops.

Mechanism Involved in P Solubilization

1. Production of organic acids: The process of phosphate solubilization by PSM is due to the production of organic acids - citric, malic, fumaric, succinic, glyoxalic acid etc. Hydroxyl and carboxyl groups of the metabolites chelate the cations (Al, Fe, Ca) bound to phosphate, then converted to soluble forms. Fumaric acid has highest P solubilizing ability.

2. Production of CO_2: Respired CO_2 reduce the pH and leads to formation of Carbonic acid Carbonic acid chelates the cations and release P.

$CO_2 + H_2O \longrightarrow H_2CO_3$ (Carbonic acid).

3. Production of H_2S: Anaerobic condition Sulphur reduced to H_2S. This reacts with Ferric phosphate by forming insoluble ferrous sulphate. Phosphate ion is released.

4. Production of inorganic acids: Organism oxidizing sulphur leads to formation of H_2SO_4 and this helps in solubilization of PO_4. Example: *Thiobacillus thioxidance.*

5. Production of Siderophores: In Acid soil, Siderophore produced by phosphate solubilizing microbes chelate to Fe and release P.

Sl No.	Organism	Predominant acid produced	Reference
1	Aspergillus niger, Penicillium sp.	Citric, glycolic, sucinnic, gluconic, oxalic, lactic.	Sperber (1958b)
2	Bacillus megaterium, Pseudomonas sp., Bacillus subtilis	Lactic, malic	Taha et al. (1969)
3	Arthrobacter sp., Bacillus sp., Bacillus firmus B-7650	Lactic, citric	Bajpai and Sundara Rao (1971a)
4	Aspergillus fumigatus, Aspergillus candidus	Oxalic, tartaric, citric, oxalic	Banik and Dey (1982)
5	Pseudomonas aeruginosa	Gluconic	Banik and Dey (1982)
6	Rhizobium	Gluconic	Van Schie et al. (1984)

Factor Affecting Solubilization

1. Carbon source.
2. Kinds of microorganisms.
3. Nature of organic acids.
4. Type of bacterial strains.
5. Root activities.
6. Co-inoculation with another inoculant.

Role of Phosphate Solubilizing Microorganism in Plant Growth and Development

1. Stimulating N- fixation
2. Production of plant growth hormones
3. Antibiotic production
4. Soil aggregation
5. Support resistance to abiotic stress
6. Increasing the accessibility of other micronutrients Fe, Zn, Mn, and Cu
7. Siderophore synthesis
8. Bio-control of plant pathogens.

The primary means by which PSM enhance plant growth is by improving P acquisition efficiency of plants, thereby converting of the insoluble forms of P to an accessible form (orthophosphate) by plants, an essential quality of PSMs. Inoculation of PSMs in soil or seed is known to enhance solubilization of applied and fixed phosphates in soil, resulting in better crop yield (Selvi *et al*., 2017). PSMs promote plant growth via generating phytohormones, such as auxins, gibberellins, cytokinins, or polyamides. PSMs also promote plant growth indirectly by increasing the accessibility of other trace elements such as siderophore. PSMs also protect plants by avoiding phytopathogens, typically owing to the production of antibiotics, hydrogen cyanate (HCN), and antifungal metabolites.

Summary

Phosphorus is a macronutrient required for the proper functioning of plants. Because P plays a vital role in every aspect of plant growth and development, deficiencies can reduce plant growth and development. Though soil possesses total P in the form of organic and inorganic compounds, most of them remain inactive and thus unavailable to plants. Since many farmers cannot afford to use P fertilizers to reduce P deficits, alternative techniques to provide P are needed. Phosphate solubilizing microbes are a group of beneficial microorganisms capable of hydrolyzing organic and inorganic insoluble phosphorus compounds to soluble P form that can easily be assimilated by plants. PSM provides an ecofriendly and economically sound approach to overcome the P scarcity and its subsequent uptake by plants.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Vitamin C and its Emphasis on Covid-19 Treatment

Article ID: 12099

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Summary

In the COVID pandemic era, the production and consumption of health supplements, especially immunity-enhancing vitamins had quadrupled. While some people tend to see this whole trend as a hoax, others are getting trapped into the fallacy of this food trend by the marketing of manufacturing companies using the tags "immunity boosters" and "COVID Superfoods" subliminally tricking the customers into buying their products. Despite these trends and the emerging "immunity-superfoods" culture, the vitamins naturally present in our daily foods also play a big role in disease prevention and recovery. One such vitamin is **vitamin C** a.k.a L-ascorbic acid about which we will discuss in this article and its relation with COVID treatment comprehensively.

Introduction

Our bodies are not capable of synthesizing Vitamin C endogenously hence, our dietary intake becomes the major source of Vitamin C. It is a water-soluble vitamin, meaning it has to be dissolved in water and delivered to the body tissues as they cannot be stored. So, including sources of Vitamin C in our diet becomes crucial. It partakes in the biosynthesis of collagen (a fibrous protein in connective tissue that is weaved throughout various systems in the body: nervous, immune, bone, cartilage, blood, and others), L-carnitine as well as some neurotransmitters. Protein metabolism also calls out for vitamin C. Furthermore, vitamin C tends to be a powerful physiological anti-oxidant that can neutralize harmful free radicals and can regenerate other antioxidants such as Vitamin E. In addition, absorption of non-heme iron, the form of iron present in plant-based foods is improved. Insufficient vitamin C intake causes scurvy - a disease that killed as many as two million sailors between 1500 and 1800, which is characterized by fatigue or lassitude, widespread connective tissue weakness, and capillary fragility. It also relates to the current pandemic we are in caused by the severe acute respiratory syndrome coronavirus 2.

Vitamin C and its Relevancy to Covid-19 Alleviation

The role of Vitamin C in the treatment and prevention of sepsis and pneumonia has been studied over the decades. The administration of VC supplements to patients affected by these diseases can reduce the severity and the elevated oxidative stress. With the help of various case studies from across the world, scientists have found the interlink between the patients affected by the Coronavirus and other critically ill-hospitalized patients to be having low levels of Vitamin C and various trials had been set up for studying the interrelation between these two. It is recently found that the main reason for the extensive lung injury is caused by the dysfunctional immune system trying to kill the virus but end up harming the patient instead, due to the excessive presence of free radicals and oxidative stress. The potent pro-inflammatory chemokines and cytokines are massively produced culminating in a multi-organ failure (making it the pervasive lethal phase) is discovered to have a correlation with the migration of the neutrophil and its accumulation in the lung interstitium and bronchioalveolar space - a key determinant of ARDS (acute respiratory distress syndrome). The adrenal and pituitary glands have three to ten times higher concentrations of ascorbic acid than any other organ. During viral exposure or ACHT simulation (physiological stress), vitamin C is released expeditiously resulting in a fivefold increase in plasma levels from the adrenal cortex. Exogenous glucocorticoid steroids being the only proven treatment for COVID-19, vitamin C escalates the production of cortisol leading to the pinnacle of anti-inflammatory responses as well as the endothelial cytoprotective effects of the same. It also plays a vital role in mediating the adrenocortical stress response thus protecting the endothelium from oxidant injury especially in cases of stepsis by being a pleiotropic stress hormone. A reduction in the length of ICU stays and a shortened requirement of ventilation period is noted when the COVID-19 patients are given Vitamin C supplements. Doses with 4-6g are found to be perfectly safe for elderly patients even with pre-existing medical conditions. Many hospitals in Shanghai, New York, and China are using intravenous Vitamin C for patients with severe Coronavirus infections. Generally, food sources that are enriched with Vitamin C such as citrus fruits, cruciferous vegetables, white potatoes, strawberries, and even bell peppers are prescribed to the patients due to the content of the former in them.

Conclusion

The improved immune response and amelioration functions due to Vitamin C are highly remarkable. With relation to the fatal phase of the COVID-19 and how it protects the endothelium from oxidative injury and downregulation of the cytokine avalanche alongside the tissue repairing capability of it, having the food supplement incorporated with sources of VC can help in alleviating and providing immune-boosting as well as an anti-inflammatory, antioxidant effect against SARS-CoV-2 infection.

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Advanced Package of Practices in Ashwagandha

Article ID: 12100

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Introduction

Ashwagandha (*Withania somnifera* L. Dunal) also known as Indian ginseng, belonging to the family Solanaceae, is an important drug in ancient Ayurvedic literature. Several types of alkaloids are found in this plant, out of which `Withanine' and `Somniferine' are important. Leaves contain five unidentified alkaloids (0.09 %), withanolides, glycosides, glucose and many free amino acids.

The pharmacological activity of the roots is attributed to the alkaloids. The total alkaloid content in roots of the Indian types has been reported to vary between 0.13 and 0.31 per cent. The drug is mainly used in Ayurvedic and Unani preparations. Withaferine-A has been receiving good deal of attention because of its antibiotic and antitumor activities.

It is used for curing carbuncles in the indigenous system of medicine. The paste prepared out of its leaves is used for curing inflammation of tubercular glands and that of its roots for curing skin diseases, bronchitis and ulcers.

Origin and Distribution

Ashwagandha possesses a natural occurrence, most probably in the drier and humid areas, spread from the Mediterranean region to throughout tropical region of Africa to South Africa and also from the Cape Verde Islands and Canary region to the Arabia and Middle East region like India, southern China and Sri Lanka. It is widely grown in dry parts of subtropical regions. Rajasthan, Punjab, Haryana, Uttar Pradesh, Gujarat, Maharashtra and Madhya Pradesh are major growing states in India.

Description of the Plant

It is an annual to perennial, branched, under shrub to herb of about 30 cm to 120 cm height, minutely stellate and tomentose branches. Roots are fleshy, tapering, whitish brown. Leaves are ovate and flowers are greenish. The mature fruits are orange-red berries.

Varieties

The Jawaharlal Nehru Krishi Vishwavidyalay, Madhya Pradesh, has released one high alkaloid variety "Jawahar" which is short in stature and most amenable for high density planting.

The variety yields in 180 days and yields a total withanolides content of 0.30 per cent in dry roots. The other varieties are "AGB-002, Jawahar Asgand-20, Jawahar Asgand-134, Raj Vijay Ashwagandha-100, Poshita" is also potential for cultivation.

Climate

It is grown as late rainy season (kharif) crop. The semi-tropical areas receiving 500 to 750 mm rainfall are suitable for its cultivation as rainfed crop. The crop requires relatively dry season during its growing period. It can tolerate a temperature range of 20 ^{0}C to 38 ^{0}C and even low temperature as low as 10 ^{0}C. The plant grows from sea level to an altitude of 1500 meter above sea level.

Soil

Ashwagandha grows well in sandy loam or light red soil having pH 7.5 to 8.0 with good drainage. Black soils or such heavy soils are suitable for cultivation.

Nursery Rising

It is propagated by seeds. Fresh seeds are sown in well prepared nursery beds. Although it can be sown by broadcast method in the main field, transplanting method is preferred for better quality and export purpose. About 5 kg of seeds are required for planting in one hectare of land. Nursery is raised in the month of June-July. Seeds are treated in carbendazim to control wilt and seed borne diseases. Seeds are sown just before the onset of monsoon and covered thinly using sand. The seeds germinate in 5 to 7 days. About 35 days old seedlings are transplanted in the main field.

Field Preparation

Two to three ploughing should be done before rains. The land is well ploughed and pulverized and brought to a fine tilth and field is then levelled.

Seed Rate and Sowing Method

A seed rate of 10 to 12 kg per ha is sufficient for broadcasting method. They can be sown in lines also. Line to line method is preferred as it increases root production and helps in performing intercultural operations smoothly.

The seeds are usually sown about 1 to 3 cm deep. Seeds should be covered with light soil in both the methods. Line to line distance of 20 to 25 cm and plant to plant distance of 8 to 10 cm should be maintained.

Manures and Fertilizers

The crop does not require heavy doses of manures and fertilizers. It responds well to organic manures and addition of 10 tones FYM / or 1 tons vermicompost per hectare is recommended. Application of 15 kg of nitrogen and 15 kg of phosphorous per hectare is beneficial for higher production.

Transplanting

After the manures are incorporated in the soil, ridges are prepared at 60 cm spacing. Healthy seedlings are planted at 30 cm spacing. In some places, 60 cm x 60 cm or 45 cm x 30 cm spacing is also followed. However, a spacing of 60 cm x 30 cm with a plant population of about 55000 seedlings per hectare is considered optimum.

Irrigation

Excessive rainfall or water is harmful for this crop. Light shower after transplantation ensures better establishment of seedlings. Lifesaving irrigation may be applied, if required. Under irrigated conditions, the crop can be irrigated once in 10 days.

Harvesting

Maturity of the crop is judged by drying out of leaves and yellow-red berries. Flowering and bearing of fruits start from December onwards.

The crop is harvested for roots by digging in January to March i.e. 150 to 180 days after sowing. There should be moisture in soil at the time of digging. Roots are dug out or ploughed using power tiller or a country plough.

Yield

On an average, 3 to 5 qt. of dry roots and 50 to 75 kg of seeds is recorded from one hectare of area. A maximum yield can be procured up to 6.5 to 7.0 q/ha. Six to fifteen mm diameter, seven to ten cm length root and 0.13 to 0.31% alkaloid are better for marketing.

Pests and Diseases

Diseases like seedling rock and blight are observed. Seedling mortality becomes severe under high temperature and humid conditions. Disease can be minimized by use of disease-free seeds and by giving seed proper treatment. Carbofuran should be applied @ 2-2.5 kg/ha at the time of sowing. Neem cake also can be applied. It will save root damage done by nematodes and insects.

Grading

A Grade: This includes root pieces of 7 cm and above in length, cylindrical and about 1 to 1.5 cm diameter. The roots are smooth and light in color with clear white starchy fractured surface.

B Grade: Root pieces of 5 cm to below 7 cm length with 1 cm diameter are included in this and brittle and white from inside.

C Grade: Root pieces of 3-4 cm length with diameter of 1.2 cm or less are included in this category.

Lower Grade: Small Root pieces, yellowish inside and rarely exceeding 3 mm diameter are lower grade.

Post-Harvest

In post harvesting the roots are separated from the plant and cut into smaller pieces i.e., 8-10cm in length and then it is air dried. After post harvesting, grading is done. The root pieces are stored in tin containers for sale. The higher the length of root pieces the higher it will fetch the price. Berries are plucked separately and then they are air dried and crushed so as to take out the seeds.

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E-ISSN: 2581 - 8317

Physiological Disorders and their Control in Date Palm

Article ID: 12101
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Introduction

Date palm (*Phoneix dactilifera* L.) is a monocotyledonous woody perennial belonging to Palmae (Arecaceae) family, which comprises of 200 genera and more than 2500 species. It is a long living dioecious evergreen with 2n=36. Date fruits are highly rich in protein, iron, B complex vitamins and folic acid. Date fruits are nutritious having high calorific value. One kilogram of fully ripe fresh date fruits provides approximately 3150 calories. Date fruits can be consumed fresh as well as after preparation of chhuhara and other products. The dry flesh of the ripe date contains about 80 per cent sugar, 2.5 per cent fibre, 2 per cent protein and 2 per cent each of fat, minerals and pectic substances. It is the major fruit crop of arid climate region, cultivated mainly in North Africa, South Asia, USA and Australia. In India the extremely dry areas comprising of Jaisalmer, Barmer and Western parts of Bikaner and Jodhpur districts are the potential regions for its cultivation. Physiological disorders are abnormalities in plants which are associated to non-pathogenic factors. A plant or its parts may show unusual growth, function or deformity. Such abnormalities are widely referred to as disorders. These may be incited by nutrients deficiency or excess, hormonal imbalance, abnormal growing conditions.

Black Nose

Black nose applies to the abnormally shriveled and darkened tip of dates. Deglet Noor and Hayani seem to be most susceptible varieties to this disorder. Black nose results from excessive checking of the epidermis, especially in the form of numerous small, transverse check or breaks at the stylar end of the fruit. Pronounced shriveling and darkening occur in proportion to the abundance of the checks and are related to humid weather at the doka stage. Bagging the fruits in brown wrapping paper inhibits the occurrence of black nose.

White Nose

It is commonly found in Iraq, Libya and Morocco. Dry and prolonged wind in the early dang stage causes rapid maturation and desiccation of the fruit resulting in whitish drying at the calyx end of the fruit. The affected fruit becomes very dry, hard and has high sugar content. Hydration may correct this condition in harvested fruits.

Crosscuts

Crosscuts or V-cuts are clean breaks in the tissues of the fruit stalk bases and on fronds. It consists of a slight to deep notch, similar to a cut artificially done by a knife. Fruits borne on strands in line with the break wither and fail to mature properly. Sayer and Khadrawy varieties are especially susceptible to this disorder. Crop losses caused by crosscuts may be avoided by using non-susceptible varieties, or by reducing the number of fruit stalks in susceptible varieties.

Barhee Disorder

It is characterized by an unusual bending of the crown of Barhee variety. The disease was first reported in California (USA) and later in Iraq. Affected palms bend mostly to the South and sometimes to the South-West. Neither the cause nor the control of this disorder is known. However, bunch handling is proposed to correct such an abnormality.

Black Scald

Black scald, different from black nose, is a minor disorder of date palm of unknown cause occurring in the United States. It consists of a blackened and sunken area with a definite line of demarcation. The disorder usually appears on the tip or sides of the fruit, and affected tissues have a bitter taste. It is suggested that the appearance of the disorder is due to exposure of fruits to high temperature, but the exact cause is not definitely known.

Bastard Offshoot

This is a deformed growth of date palm vegetative buds especially of offshoots fronds. The bastard condition could be due to infestation of date palm by bud mite. It may also be due to reduction in growth caused by an in equilibrium of growth regulators. Control of mite by suitable insecticide also reduces the incidence of this disorder.

Leaf Apical Drying

A physiological reaction to transplantation of adult palms (injury of their root system). All palms with these symptoms recover within two to three years after their transplanting.

Fertilization Injury

This type of injury is present only with young tissue culture derived palm plants (first two years after field planting) and when fertilizers (N, P, K) are applied to close to the palm's stipe. The nature of fertilizers is not the cause, but rather how close to the stipe the fertilizer was applied. If the damage is severe, it could cause the death of the young palm.

Frost Damage

The date palm resists large temperature variations (-5 to 50^0 C) with a growth optimum between 32 and 38^0 C and a zero of vegetation of about 7^0 C. The vegetative activity will also decrease above 40^0 C and ceases around 45^0 C. When temperature falls below 0^0 C, it causes metabolic disorders with some injury to date palm leaves characterized by a partial or total desiccation. During defrost, water invaded inter-cellular spaces and affected leaves turn brown and desiccated. The severity of damage is related to the intensity and duration of frost.

Lack or Excess of Water

The growth of the date palm is highly affected by variations in water content of the soil. A decrease in yield or complete failure in fruit production could result from these water variations. To compensate for high evapotranspiration, the date palm requires a quantity of water from 1500 to 2800mm/year. Prolonged water stress will significantly decrease growth and yield, and if, the drought continues for several years, date palm can dry up and die. To provide optimum level of water to the plant.

Conclusion

The proper fertilization, irrigation, use of resistant varieties and certified seedling will helps in reducing the incidence of physiological disorders, improves the fruit quality and productivity of date palm.

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Diseases of Rice and their Management

Article ID: 12102

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Rice (*Oryza sativa L.*) is a staple food in many countries and provides food security to millions of populations in the world. It is one of the major food crops of India and most of rice is consumed and grown in Asia where 60% of the earth's population live. The major concern is to increase the productivity of rice to fulfill the demand of increasing population. The major biotic constraints for rice are Leaf and Neck blast, Brown spot, Sheath blight, Bacterial leaf blight, False smut and Tungro. The productivity of the rice can be increased only by reducing the losses occurring due to pest and diseases.

The Major Diseases of Rice with their Symptoms are Enlisted Below

1. Blast of Rice (*Magnaporthe grisea*):

Symptoms - The pathogen attacks on all stages of crops from seedling to flowering stage. The symptoms of blast can be observed as leaf blast, node blast or neck blast. In leaf blast spindle shaped spots with grey colour center and dark brown margins can be seen and later these spots merge together and give burnt appearance in the field. The node blast is characterized by irregular black areas encircling the node and later nodes may break and plant above node die. The neck blast is marked by brownish-black lesions on peduncle and glumes. In early infection, no grain filling is there and panicle remains erect like dead heart. In late infection, partial grain filling is seen.

2. Brown Spot of Rice (*Helminthosporium oryzae*):

Symptoms – The fungus infect crop starting from seedling stage to milking stage. The disease appears as minute brown dots on coleoptiles, leaf blade, leaf sheath and glumes and most prominent on leaf blade and glumes. The spots later become oval to circular and join together to form large spots and leaf dries up. The death of seedlings can be noticed by brownish scorched appearance in the field. Dark brown or black spots are also noticed on glumes containing large number of conidiophores and conidia. It leads to failure of seed germination, seedling mortality and reduced grain quality.

3. Sheath Blight of Rice (*Rhizoctonia solani*):

Symptoms – The pathogen affect crop from tillering to heading stage. Initial symptoms are seen on leaf sheath as oval or elliptical or irregular greenish grey spots. The lesions on upper parts of plant spread rapidly merging with each other to cover entire tillers from water line to flag leaf. The death of whole leaf occurs or plant may show blighted appearance. The heavily infected plants produce poorly filled grains.

4. Bacterial Leaf Blight of Rice (*Xanthomonas oryzae* pv. *oryzae*):

Symptoms - The bacteria produce either wilting or leaf blight symptom. In the seedling stage (3-4 weeks after transplanting) wilting can occur known as 'kresek'. It leads due either wilting of few leaves or death of the entire plant. During heading stage, water-soaked translucent lesion develops near the leaf margin and it enlarge and turn straw yellow colour within few days. The lesions slowly cover the entire leaf giving it white or straw colour. In the morning, milky drops containing bacteria can be seen and they dry forming white encrustation. The grains show discoloured spots surrounded by water-soaked areas.

5. False Smut of Rice (*Ustilaginoidea virens*):

Symptoms - The individual grains are transformed into yellow or greenish spore balls of velvety appearance which are initially small and become large at later stages. The ovaries are converted into velvety green masses due to fructification of the pathogen and few spikelets in panicle are affected.

6. Rice Tungro (Rice tungro bacilliform virus and Rice tungro spherical virus)

Symptoms – The leaves show yellow to orange discoloration and interveinal chlorosis. Pale green to whitish interveinal stripes is observed on young leaves while older leaves show rusty streaks. The plants are stunted with poor root system and tillering is also reduced. In infected plants, panicles are small with fewer spikelets.

Integrated Disease Management

1. Use of disease-free seeds.
2. Growing of resistant varieties.
3. Proper fertilization and split application of nitrogenous fertilizers.
4. Remove and destroy weed host.
5. Destroy the affected stubble by burning or ploughing.
6. Seed treatment with *Pseudomonas fluorescens* @ 10g/kg seeds or *Trichoderma viride* @ 4g/kg seeds
7. Seed treatment with Carbendazim or Captan or Thiram @ 2g/kg seeds.
8. Spraying with Tricyclazole @ 0.06 % or Thiophanate methyl @ 0.1% for Rice blast.
9. Spraying with Propiconazole @ 0.1% or Hexaconazole @ 0.2% for sheath blight.
10. Spraying with copper oxychloride @0.3% at panicle emergence stage for false smut.
11. Destroy the leaf hoppers vector of tungro virus by spraying Neem oil @3%, Phosphomidon @ 1ml/l or Monocrotophos @ 2.2ml/l at 15 and 30 days after transplanting.

The various methods used for managing rice diseases include cultural practices, use of resistant varieties, biological control and chemical control. All these methods differ in degree of their success and selection of any particular method depends on the pest population, various region, cost involved in the management, time of application, etc. A single control measure is not enough to give the satisfactory results so we should incorporate all the management practices for managing a particular disease. The use of resistant varieties is very cheap and economical among all the methods so it should be surely adopted to control the disease. The use of chemical pesticides should be our last priority as it leads to environmental pollution and various health hazards.

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E-ISSN: 2581 - 8317

Preparation and Management of Quality Farm Yard Manure

Article ID: 12103

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Farm Yard manure refers to a decomposed mixture of solid and liquid excreta (dung) of cattle along with the litter that may include the left-over fodder and feed or animal bedding such as, straw, crop waste, leaf litter etc. FYM is an excellent organic material that improves physical, chemical and biological conditions of soil. Soil organic matter is the key to soil fertility and productivity. In the absence of organic matter, the soil is a mixture of sand, silt and clay. FYM have long been utilized by the farmers to supply nutrients to crops but, during the last three decades greater emphasis has been given to the use of chemical fertilizers. One reason for this could be the non-availability of adequate amount of FYM as a part of it is being utilized for fuel purposes. Despite being ignorant about the composition of FYM, the ancient people were fully convinced with the fact that FYM application certainly increases the fertility of soil, sustains soil health and crop productivity because of the presence of essential nutrients required for crop growth. Long term experiments have clearly shown that in addition to fertilizers, the use of organic manure is essential to sustain soil health and crop productivity. Today's, intensive agriculture when over soils have started showing signs of fatigue due to their over exploitation, a good quality FYM is one of the mainstays of sustaining the soil a health. To maintain the soil productivity, the use of FYM can go along way because it contains all the essential nutrients required for the crop growth.

It has been estimated that organic resources available in the country alone can produce not less than 20 million tons of plant nutrients (NPK). The disposal of ever-increasing amounts of organic wastes is becoming a serious problem. The hygienic disposal of organic wastes by composting is an environmentally sound and economically viable technology resulting in the production of organic fertilizer which is a basic and valuable input in organic farming. In India, about 350 million tons of agricultural wastes are generated annually is in major portion.

The biological treatment of these wastes appears to be most cost effective and carry a less negative environmental impact. In Many areas the traditional management practice of post-harvest residues is the elimination by open air burning leads to release of greenhouse gases and the production of particulate matter are obvious.

Therefore, as an alternative to burning of agricultural residue, the incorporation into the soil stands to reason, this has been widely accepted. The regular recycling of organic wastes in the soil is the most efficient method of maintaining optimum levels of soil organic matter. Recycling of organic matter in the soil should become a regular feature of modern agriculture. In the traditional agriculture, followed over generations in India, the use of plant and animal wastes as a source of plant nutrient was the accepted practice.

Beneficial Effects and the Nutrient Content of Good Quality FYM

When a good quality FYM is applied to soil, it brings about considerable amount in the soil environment that leads to enhanced soil productivity. It increases organic matter content in the soil, improves soil structure, tilth, aeration and enhances water and nutrient capacity of the soil. It promotes soil microbial activity that makes essential plant nutrients in soil available to crops. It checks the occurrence of micro-nutrient deficiencies. It also acts as an excellent amendment for alkali soils. Adds structure to light and sandy soils. Ideal for mulching.

Application of Farmyard Manure

1. 15-20 days before sowing or transplanting.
2. 50 to 100 tones/ha.
3. Improves soil fertility.

About 55% of nitrogen and nearly 82% of Potassium is found in urine and the cattle dung has remaining 45% of nitrogen and 18% of Potassium. Almost whole of the Phosphorus is present in the dung. The quality of FYM varies significantly depending upon the kind and age of animal, condition and the function of animal, the animal feed, the nature and type of litter used as bedding and the degree of decomposition. In addition, leaching and the gaseous loss of nutrients while collecting and storing the cattle excreta and cattle farm waste also influenced the quality of FYM. Based on its nutrient content on dry weight basis, one tonne of well decomposed FYM can supply 7-20 Kgs nitrogen, 3-7 Kgs of phosphorus, 2-28 Kgs potassium, 2-38 Kgs of calcium, 2-7 Kgs of magnesium and 1-3 Kgs sulphur.

Practice Among Farmers

It is highly unfortunate that in our state the cattle dung and urine as well as yard waste are not properly handled and managed by the farmers. The biggest drawback is that either no bedding is used to urine and if at all used, it is inadequate as well as of poor quality. As such, substantial amount of nitrogen, potassium and sulphur present in the cattle urine does not form a part of the so called FYM. In addition, the cattle dung is carelessly dumped in big heaps in the open without any protection against sun and rain.

Under this situation, a considerable amount of nutrients gets lost in the form of gases because of exposure to very high temperature during summer and through leaching due to heavy rains during rainy season. The loss of nitrogen can be minimised if cattle urine is soaked by absorptive crop residue applied as animal hay bedding that helps to minimised the chances of gaseous loss of nitrogen. Obviously, it is essential good quality FYM which could go a long way in maintaining the soil health and productivity.

Preparation of Good Quality FYM

First and the most important is to collect the cattle dung and dressings in such a manner that the cattle urine becomes a part of FYM. It should make a practice to spread some good absorbing bedding material under the animals that sufficiently absorps the cattle urine. Paddy straw, available in plenty in our state and known to soak urine 3-4 times of its dry weight, may be effectively used as a bedding under the animals.

1. Digging a trench: Dig a trench depending upon the number of cattle. Normally a trench, measuring 4 metre long, 2 metre wide and 1metre wide is adequate for managing dung and urine etc. Of 3 to 5 animals. This trench should be dug at such a place where the rain water gets pounded. Otherwise, make bunds around the trench to avoid loss of humus from FYM in the rain water.

2. Collecting cattle dung and urine etc. in the trench: If possible, the trench should be filled with the mixture of dung and urine-soaked litter in three equal parts. First of all, spread a layer of farm/crop waste that can absorb moisture. Then, fill it up with the mixture of dung and urine-soaked bedding daily by spreading the same uniformly in the first one third part of trench. When this portion of t trench gets filled up to 45-60cm above the surface of soil, plaster it with dung paste. Subsequently, fill up the remaining two parts of pit in the same way.

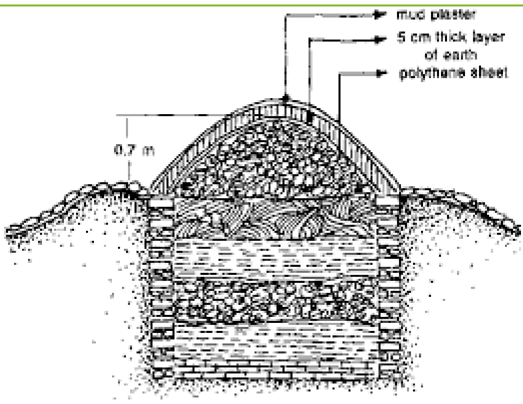
Cattle dung collected and managed in this way in the pit is fully decomposed in about three months. It gets converted into an ideal FYM with a good texture, worth applying to the fields. Proper management and use of FYM can conserve more than 75% of the nutrients contained in cattle urine and dung.

Different Methods of Preparation of Good Quality FYM

There are three different methods of FYM:
1. Trench Method.
2. Pit Method.
3. Heap Method.

Trench Method of Preparing FYM

This method has been recommended by Dr. C. N. Acharya. The manure preparation should be carried out in trenches, having size of:
1. 6 to 8 m length.
2. 1.5 to 2 m width.
3. 1 to 1.25 m depth.
4. The top of the heap is made into a dome and plastered with cow dung earth slurry (50cm).
5. 4 to 5 months after plastering.



In the Pit Method of FYM, the Cattle Shed Wastes are Conserved in Pits of

1. 2 m wide.
2. 1 m deep and of convenient length.
3. Sloping bottom towards one end.
4. Well-mixed dung, urine and straw are spread to form a layer of 30 cm thick.
5. Pressed, moistened if dry and covered with a 3 – 5 cm layer of well ground fertile soil to hasten the decomposition and to absorb the ammonia.
6. One pit is required (two animals).
7. 150 to 180 days.
8. 10 to12 tonnes of FYM obtained/pit.

Heap Method

Table 1. nutrient content ranges on dry weight basis in a well decomposed Farm yard manure:

Nutrient	Content %	Nutrient	Content mg/kg
Nitrogen	0.7-2.0	Zinc	20-160
phosphorus	0.3-0.7	Copper	10-110
Potassium	0.2-3.8	Manganese	60-340
Magnesium	0.2-0.7	Iron	800-2650
Sulphur	0.1-0.3	Boron	12-72

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E-ISSN: 2581 - 8317

Papaya - Tropical Fruit - Health Benefits

Article ID: 12104

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Papaya (*Carica papaya* L.) is a deliciously sweet tropical fruit with musky undertones and a distinctive pleasant aroma. It was first cultivated in Mexico several centuries ago but is currently being cultivated in most of the tropical countries. Papaya is common man's fruit with a high nutritive value available at a reasonable price. It is rich in natural vitamins, minerals and low calorific value. The papaya can be considered as a nutrient dense food, as it provides many more nutrients. The nutritional qualities and medicinal value of papaya are closely related. The different parts of the Papaya (Carica papaya Linn.) belonging to the family Caricaceae such as leaves, seeds, latex and fruit possess excellent medicinal properties for treatment of different ailments. The stem, leaf and fruit of papaya contain plenty of latex. Papaya is a natural remedy for many ailments, including atherosclerosis, heart disease, and rheumatoid arthritis, and helps keep digestive and immune systems healthy.

Health Benefits of Papaya

1. Helps in reducing overweight: The low calories content (32 Kcal / 100 g of ripe fruit) makes a favourite fruit of obese people who are into weight reducing regime.

2. Promotes the functioning of digestive system: Papain present in good amount in unripe fruit is an excellent aid to digestion, which helps to digest the protein in food at acid, alkaline and neutral medium, prevent bloating and chronic indigestion. Papaya contains two important biologically active compounds vis: hymopapain and papain which are widely used for digestive disorders. Papaya-derived components can improve acidic pH conditions and pepsin degradation. The celiac disease patients, who cannot digest the wheat protein gliandin, can tolerate it, if it is treated with crude papain.

3. Excellent source of fibre: The whole papaya fruit is an excellent source of dietary fibre and therefore can also help in preventing the constipation. The fibre content of papaya can help in lowering the high blood cholesterol levels

4. Acts as a tenderizing agent: Papaya has the property of tenderizing meat. This knowledge is being put to use by cooking meat with raw papaya to make it tender and digestible.

5. Act as an anti-oxidant: The fermented papaya fruit is a promising nutraceutical as an antioxidant. It improves the antioxidant defence in elderly patients even without any overt antioxidant deficiency state at the dose of 9 g/day orally. The major groups of phytochemicals that have been presented in papaya acts as a natural source of antioxidants may contribute to the total antioxidant activity of plant materials including polyphenols, carotenoid and traditional antioxidant vitamins such as vitamin C and E.

6. Helps in iron absorption: Papaya markedly increases iron (Fe) absorption from rice meal in human body.

7. Helps in prevention of cancers: Papaya is an effective anti-cancer agent against cervix, breast, liver, lung and pancreas cancers. The leaves, seeds and juice of papaya show free radical scavenging and antioxidant activity. Papaya is a store-house of cancer fighting lycopene. Papaya also contains the flavonoid beta carotene, which studies have proven to help protect against lung and mouth cancers. Cancer can be eradicated through daily intake of papaya, as it contains chemical integrates such as lycopene and others. Papain, the main proteolytic enzyme in papaya, is also being studied for relief of cancer therapy side effects, especially in relieving the side effects such as difficulty in swallowing and mouth sores after radiation and chemotherapy as well as boosting up the immune system and helping body to fight against the cancer cells.

8. Rich source of vitamin A: Papaya contains good source of Vitamin A which is required for healthy skin, mucous membranes, and vision, and especially effective against macular degeneration. It provides 31% of the daily value of vitamin A for human body. It contains relatively high levels of beta-carotene, which the body converts to vitamin A. The consumption of papaya is therefore recommended to prevent the vitamin A deficiency, a cause of childhood blindness in many tropical and subtropical developing countries.

Our bodies need vitamin A for the maintenance of epithelial surfaces, for immune competence, normal functioning of retina, as well as for growth, development and reproduction.

9. Rich source of Ascorbic acid: Vitamin C is one of the strong points of papaya, providing a whopping 144% of the daily recommended value per serving, which is great as an infection fighter as well as a free radical-scavenging antioxidant.

10. Good source of B-complex vitamins: The B vitamins in papayas such as folic acid, pyridoxine (vitamin B6), riboflavin, and thiamin (vitamin B1) are called "essential" because they're required by the body, but not produced within, so they are required through the diet to provide what is to be metabolized, thus including foods like papaya in your diet is important.

11. Reduce the risk of cardio vascular diseases: Folic acid is needed for the conversion of homocysteine to cysteine and methionine. The increased level of homocysteine in blood is considered a significant risk factor for a heart attack or stroke as it can directly damage the wall of blood vessels. Papaya could be a candid source to reverse the homocysteine mediated cardiovascular diseases since it has profuse amount of folic acid. Because of its high antioxidant contents, papaya can prevent cholesterol oxidation and can be used as a preventive treatment against atherosclerosis, strokes, heart attacks and diabetic heart disease.

12. Strengthen the immune system: Papaya can strengthen the immune system therefore can help in preventing the recurrent colds and flu. After treatment with antibiotics eating papaya or drinking its juice can help to replenish the intestinal microflora. The fermented papaya products showed free radical scavenging activity and were effective in providing protection against various pathological disorders including tumors and immunodeficiency.

13. Anthelmintic and anti-amoebic properties: In folk medicine, C. papaya seeds have been used to treat the antheminthiasis. The papaya fruit, seeds, latex, and leaves contain carpaine, an anthelmintic alkaloid that can remove the parasitic worms from the body. The papaya seeds when taken with honey are known to be anthelmintic for expelling the worms. The latex of papaya as well as the aqueous extracts of papaya seeds have shown potent anthelmintic and anti-amoebic properties.

14. Anti-inflammatory and wound healing properties: Papaya is thought to contain some natural pain-relieving abilities. The unique protein digesting enzymes (papain and chymopapain) have been reported to help in lowering the inflammation and healing of burns. Papaya can lower inflammation in the body, alleviate pain and edema caused by sport injuries. The antioxidant nutrients found in papaya, including vitamin C, vitamin E, and beta-carotene can also help in reducing inflammation. Because of its anti-inflammatory properties papaya can relieve the severity of rheumatoid arthritis, polyarthritis and osteoarthritis.

15. Support for the immune system and anti-mutagenic properties: Vitamin C and vitamin A are both needed for the proper functioning of a healthy immune system. Papaya contains significant quantities of vitamin C and provitamin A (beta-carotene) and therefore may be a healthy fruit choice for preventing such illnesses as recurrent ear infections, colds and flu.

The supplements produced by dehydrating and concentrating the whole fruit may be helpful for people who do not get enough of these components in their daily diet. Dried papaya is marketed in tablet form to remedy digestive problems. Papaya pills, juices, and whole food supplements containing papaya are currently being promoted as weight loss aids, digestive aids, and natural pain relievers, as well as for many other health benefits.

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E-ISSN: 2581 - 8317

Artificial Intelligence - A Way to Smart Agriculture

Article ID: 12105

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Introduction

According to UN Food and Agriculture Organization, the population will increase by 2 billion by 2050. However, only 4% additional land will come under cultivation by then. In this content, use of latest technologies solutions to make farming more efficient, remains one of the greatest imperatives. While Artificial Intelligence (AI) asses a lot of direct application across agricultural sectors.

So, a growing number of enterprises are creating solutions for agricultural systems, based on AI capable of solving multiple problems and saving valuable resources by reducing environmental damage. Hence AI appears as an innovative technology that can support the businesses struggling through the COVID-19 pandemic, especially in the agricultural industry.

Artificial Intelligence has an important role to play in transforming food systems and helping to address food and nutrition insecurity. In the agricultural sectors, it can do so in several ways, including optimizing or even carrying out some human activities, such as planting and harvesting, thus increasing productivity, improving working conditions - by reducing the amount of time and toil - and using natural resources more efficiently, including through better knowledge management and planning.

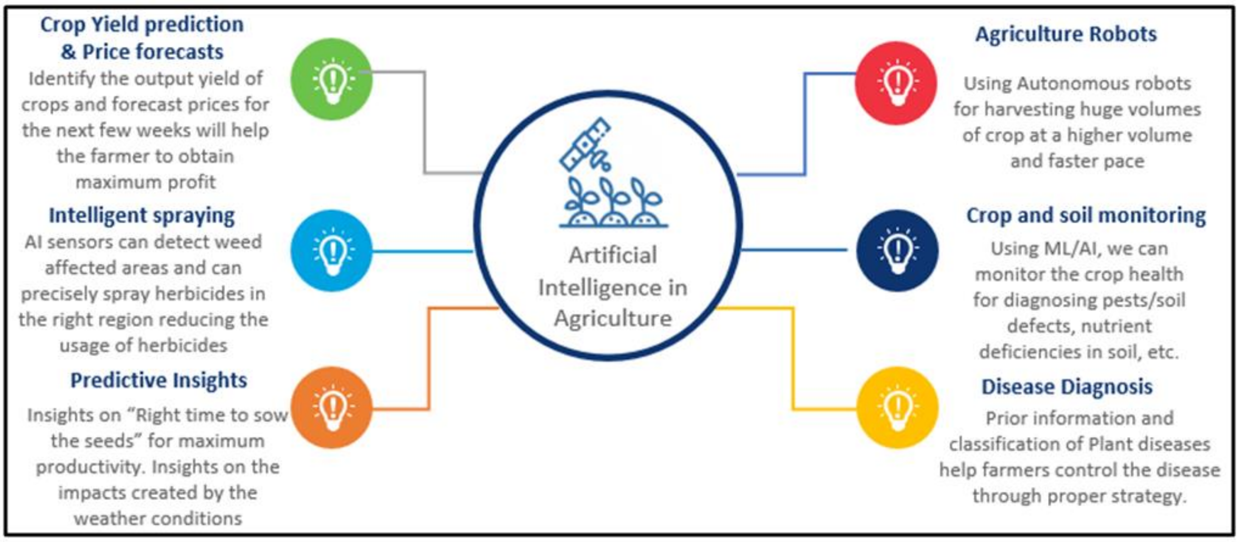
Artificial Intelligence

Artificial intelligence (AI) is a wide-ranging branch of computer science concerned with building smart machines capable of performing tasks that typically require human intelligence. Artificial Intelligence in Agriculture not only helps farmers to use their farming skills but also shifts to direct farming to get higher yields and better quality with less resources.

AI-based technology helps to improve efficiency in all sectors and manages the challenges facing various industries including various sectors in the agricultural sector such as crop harvesting, irrigation, soil content sensitivity, crop monitoring, weed, harvest and establishment. AI technology helps diagnose plant diseases, pests, and malnutrition on farms and AI sensors can detect and identify weeds.

Agricultural Stress Index System

The Agricultural Stress Index System (ASIS) is a quick-look indicator developed by FAO for the early monitoring of agricultural areas with a high likelihood of water stress/drought at global, regional and country level, using satellite technology. Drought affects more people than any other type of natural disaster and is the most damaging to livelihoods, especially in developing countries.



Agricultural Robots

Agricultural robots' primary purpose is to automate field activities, allowing farmers to focus on more vital jobs while saving time on tedious, repetitive tasks. Seeding, harvesting, weed management, tilling, chemical application, and other applications are all possible with these robots. Furthermore, by substituting agricultural vehicle drivers with software and hardware complexes, waste can be reduced and yields can be increased due to more exact land cultivation.

Eventually, the world of agriculture will shift to automated farming as mobile and fixed robots become more common. The prominent tasks of robotics in Agriculture are:

1. Monitoring and forecasting.
2. Production costs reduction.
3. Activities precision and quality improvement.
4. Minimization of food production impact on the environment.
5. Support of medium and small agricultural businesses.
6. Increased food safety.
7. Ability to use agricultural robots in any weather, any time of the day.

Crop and Soil Monitoring

AI solves critical farm labor challenges by augmenting or removing work and reducing the need for large numbers of workers. Agricultural AI bots are harvesting crops at a higher volume and faster pace than human laborers, more accurately identifying and eliminating weeds, and reducing cost and risk. AI farmers present a permanent solution for the unpredictable and fluctuating agricultural workforce.

After the seeds are planted, IoT devices continue to monitor growth, weeds, soil and water retention, and other factors which in turn inform next year's crop. Instead of relying on human measurements and labor, automated food and irrigation systems ensure the crops have the proper nutrients.

Additionally, farmers are taking advantage of chatbots to seek advice and recommendations on specific problems. Chatbots are already used in numerous industries with great success, so it's no surprise that AI-powered chatbots should help farmers as well.

Disease Diagnosis

Before AI techniques can be deployed for plant disease detection, they need to be trained with large datasets that can be generated from different plant leaf images such as infected and fresh.

This will allow models to differentiate between infected and fresh plants. These datasets often exist as images of different plant species and in different combinations like infected and healthy.

Future of AI in Agriculture

As global population size increases, farmers now have to produce more food to feed a growing community, and the introduction of robotics and a digital workforce can offer automated assistance. Genetically modified ingredients and food products promise customers access to fresh seasonal food year-round, which means farms have to depend on data to create longer seasons, bigger fields or different grow times.

The future of AI in agriculture will need a major focus on universal access, as most cutting-edge technologies are only used on large, well-connected farms. Increasing connectivity and outreach to even small farms in remote areas across the world will cement the future of machine learning automated agricultural products and data science in farming.

Conclusion

As the conclusion, AI, machine learning (ML) and the IoT sensors that provide real-time data for algorithms increase agricultural efficiencies, improve crop yields and reduce food production costs. Also, artificial intelligence applied to agriculture has the potential to improve farm planning, optimize resources, and significantly reduce waste.

More than 75 million agricultural linked devices are predicted to be in use by the year 2020, with the average farm generating an average of 4.1 million data points per day in 2050. According to UN population and hunger projections, the global population will grow by 2 billion people by 2050, necessitating a 60 percent increase in food productivity to feed them.

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E-ISSN: 2581 - 8317

Jalkund- A Low-Cost Rainwater Harvesting Structure for Life-Saving Irrigation

Article ID: 12106

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Introduction

Water is one of the most essential components in effective crop production in agriculture. During the dry season, farmers have a major challenge in terms of water availability, which makes farming difficult. Rainwater harvesting serves to minimise run-off that clogs storm drains, reduce flood dangers, augment groundwater storage and manage water level drop and prevent soil erosion, in addition helps to helping to satisfy the ever-increasing need for water. Rainwater is bacteriologically clean, organic matter-free, and naturally soft. The rainwater collection structures described are simple, cost-effective, and environmentally beneficial. *Jalkund*, a micro rainwater collecting structure, is an appropriate solution for increasing climate resilience and enhancing the livelihood of small and marginal farmers in Manipur. As per the ICAR Research Complex for NEH Region, Manipur Centre, during 1954-2017 periods, Imphal West district receives normal annual rainfall of 1450 mm per year. Every year, almost 80% of the annual rainfall falls during the monsoon season and from November to mid-May; Manipur faces water shortage for drinking as well as agriculture. Rainwater collecting and wise usage for agricultural production can help to alleviate this problem. Farmers can benefit greatly from direct rainwater collection through water catch ponds/pits (*Jalkund*) for irrigation of crops during dry seasons when moisture is scarce. During the rainy season, rainwater may be collected and stored in *Jalkund*, which can then be used to give protected irrigation to crops for effective agriculture. Otherwise, runoff may result in soil erosion and nutrient loss. High-value vegetable crops such as broccoli, carrot, cabbage, onion, potato, tomato, pea and cucumber may be grown with harvested water. Besides, animal husbandry operations, such as piggery, poultry, and duckery, can be benefited from stored water. Fish rearing can also be done in the water that has been collected.

About Low-Cost Rainwater Harvesting Structure-*Jalkund*

Jalkund a low-cost rainwater harvesting structure was developed by ICAR Research Complex for NEH Region, Umiam, Meghalaya. It was tried and developed at the ICAR Research Farm, Umiam, Meghalaya. The storage capacity of *Jalkund* ranges from 6,000 litres to 60,000 litres depends on dimensions of the structure. The different dimension of *Jalkund* is given Table 1.

Table 1. Different dimensions of *Jalkund:*

Capacity of Jalkund (Liters)	Length (m)	Breadth (m)	Depth (m)
6,000	3	2	1.0
9,000	3	2	1.5
12,000	4	3	1.0
15,000	5	2	1.5
18,000	4	3	1.5
30,000	5	4	1.5
60,000	8	5	1.5

Jalkund, follows the very easy procedure for construction and it is easy to make. Some of the main steps concerned in the building of *Jalkund* are given below:

1. *Jalkund* building requires careful site selection, especially in hilly places, but in plain areas, it may be built anywhere based on water collecting opportunities and the position of the farm or kitchen garden. Following the selection of the location, the site is cleared of any undesirable items.
2. Following the removal of any undesirable debris, the site is dug according to the size of the *Jalkund*, which is determined by the storage capacity, water harvesting capacity, and available space.

3. To prevent damage to the lining material, the side slopes and bottom of *Jalkund* are being smoothed by removing stones, boulders, and other protrusion. Insecticide is sprayed on the interior walls and bottom of the *Jalkund* to keep rodents and pests at bay.
4. Plastering of the interior walls and bottom of the *Jalkund* is done using a 5:1 combination of clay and cow manure.
5. Following the clay-cow dung plastering, dry pine leaf is utilised to cushion the *Jalkund* at a thickness of around 3-5 cm to prevent harm to the lining material.
6. *Jalkund* is lined with LDPE agro film (minimum thickness of 250 m) after it has been cushioned. To prevent agri-film movement, the outer edge of the film is buried in the soil.

For safety, a low-cost fence constructed of bamboo or locally available material may be installed, and Jalkund might be covered with a temporary thatch grass roof to avoid evaporation.

Distribution LDPE agri-film Silpoulin to the farmers of Imphal West district

Lining of LDPE (250 µm) in the *Jalkund* at Langol, Manipur

E-ISSN: 2581 - 8317

***Jalkund* having storage capacity of 30,000 litres of water constructed at Longsachung village, Nagaland**

***Jalkund* constructed at Wokha village, Nagaland**

Different Uses of Harvested Water from Jalkund

The stored water is essential for irrigating agricultural plants. *Jalkund's* stored water may be used for a variety of purposes, including irrigating crops, raising animals (pigs, poultry, etc.), and household usage. The following are a few examples of its applications.

Vegetable Production

Vegetable crops such as tomato, broccoli, cabbage, cauliflower, potato, onion, and others may be grown all around the Jalkund's perimeter to boost farm revenue. The stored water of *Jalkund* can maintain 200 tomato plants in a 250 m^2 area, as well as animal raising during the lean season, based on per unit water requirements.

The *Jalkund* for crop production were adopted in the Imphal West district of Manipur. The crop grown were broccoli, carrot, cabbage, onion, potato, tomato, pea and cucumber; and total area covered was 144 m^2 and total volume of water used was 60,000 litres. The crops grown were allotted an area from range from 16 - 20 m^2.

Table 2. Different vegetables grown using *Jalkund* water:

Sl. No.	Crop	Water Req. (mm)	Area (m2)	No. of plants	Volume of water used (litres)
1	Broccoli	500	16	60	8000
2	Carrot	400	17	4500	7000
3	Cabbage	420	20	98	8000
4	Onion	500	18	578	8000
5	Potato	550	20	120	10000
6	Tomato	420	16	53	8000
7	Pea	375	20	780	6000
8	Cucumber	250	17	45	5000
Total		**427**	**144**	**6234**	**60000**

The crop water requirement of potato was highest among all crops at 550 mm per season. The other crops like broccoli, onion and cabbage, the crop water requirement was at 500 mm per season. The water requirement of cabbage and tomato were at 420 mm, while pea was at 375 mm.

The crop water requirement of remaining crops carrot and cucumber were at 400 mm and 250 mm respectively. The total number of plant available under this model is 6234 numbers and the details are given in Table 2.

Livestock and Fish Production

Pig-based farming: During non-monsoon seasons, water demand of pig farming could maintain five piglets for 200 days using water from the *Jalkund* (30000 l capacity).

Poultry-based farming: *Jalkund* (30,000 l capacity) can provide water to 50 numbers of poultry birds for 200 days throughout the year's water-stress months (November to May).

Fish and duck-based farming: The *Jalkund's* stored water may be utilised in part to integrate fish-cum-duck farming, with Azolla being used as a fish feed. Fish feed was made from the excrement of ducks raised in the *Jalkund*. Besides fulfilling the water needs of rabi crops, the *Jalkund* water also could maintain 1000 one-month-old fish seedlings or 25 five-month-old fish with two ducks.

Conclusion

Rainwater harvesting, regardless of the technique employed, entails collecting and storing rainwater during times of excess for use during times of scarcity. It may be inferred that the use of rainwater harvesting technology boosts agricultural productivity, raises farmers' living standards, and lowers environmental damage. Rainwater collection is also beneficial to farmers in regions where irrigation is difficult to implement. *Jalkund*, as a low-cost water collecting structure, may be effectively used for irrigation and other agricultural purposes in hilly and valley areas of north eastern India. Because, it is simple to create and has a low cost associated with it. Farmers may simply construct *Jalkund* as a water collecting structure or reservoir in their backyards or on their agricultural sites as needed.

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E-ISSN: 2581 - 8317

Biochar: Organic Mitigation Option of Heavy Metal Toxicity

Article ID: 12107

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Abstract

Soil contamination with heavy metals and organic pollutants has increasingly become a serious global environmental issue in recent years. Biochar has a large surface area, and high capacity to adsorb heavy metals and organic pollutants. Biochar can potentially be used to reduce the bioavailability and leachability of heavy metals and organic pollutants in soils through adsorption and other physicochemical reactions. Biochar is typically an alkaline material which can increase soil pH and contribute to stabilization of heavy metals. Application of biochar for remediation of contaminated soils may provide a new solution to the soil pollution problem.

Introduction

In recent years, soils are subjected to waste emissions from industrial production, mining activities, waste (i.e., biosolids and manures) application, wastewater irrigation and inadequate management of pesticides and chemicals in agricultural production (Bolan et al. 2004). The enhanced concentration of heavy metals in soil and water exhibits toxic effects on to living organism. Pollutants in soils are not only harmful to ecosystems and agricultural production but also a serious threat to human. Biochar (Lehmann, *et al.*, 2006) emerged in the recent years as a win–win option that can act both as a carbon sink and as an amendment improving soil quality, increase fertility, and water holding capacity, thereby preventing risks for land degradation. Production of biochar occurs via a thermochemical process called pyrolysis. Pyrolysis is the thermal decomposition of biomass at high temperature and in the absence of or under very low oxygen concentration and is associated with the production of three by-products: biochar (solid), bio-oil (liquid), and syngas (gas) (Alexandre and Cherubini (2019). Biochar is the solid product from pyrolysis of waste biomass residues from agricultural and forestry production (Wang et al. 2010). Application of biochar to soil has been considered as to having great potential to enhance long-term carbon sequestration because most carbon in biochar has an aromatic structure and is very recalcitrant in the environment (Lehmann 2007). Typically, biochar has a high pH value and cation exchange capacity, and can enhance soil productivity (Jeffery et al. 2011). A number of studies have also demonstrated that biochar has a high capacity to adsorb pollutants in soils (Beesley et al. 2011). In this article we aim to explore the potential of using biochar for mitigation of contaminated soils.

Biochar for Remediation of Soils Contaminated with Heavy Metals

Biochar can stabilize heavy metals in the contaminated because these salts can precipitate with heavy metals and reduce their bioavailability (Cao et al. 2009). Heavy metal exchange with Ca^{2+}, Mg^{2+}, and other cations associated with biochar. Biochar pH value increases with pyrolysis temperature because of increased ash content in biochar (Wu et al. 2012). Therefore, most biochars are alkaline material and have a liming effect, which contributes to the reduction of the mobility of the heavy metals in contaminated soils (Sheng et al. 2005).

Effect of Biochar on Heavy Metal Mobility

Biochar application can reduce the mobility of heavy metals in contaminated soils which renders a reduced risk of taking up by plants. Biochar application can also reduce the leaching of metals through its effect of redox reactions of metals. Therefore, most biochars are alkaline material and have a liming effect, which contributes to the reduction of the mobility of the heavy metals in contaminated soils (Sheng et al. 2005). However, the adsorption ability of the same type of biochar varies with different types of heavy metals.

Conclusion

Biochar has the potential as technology for remediation of contaminated soils. Obviously, biochar can conceivably reduce the bioavailability and efficacy of both heavy metal and organic pollutants in soil.

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Heavy Metal Tolerance in Crops: Achievements and Challenges

Article ID: 12108

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Heavy metal (element having density > 5g/cm^2) contamination is a serious global problem for all biota (Jarup L., 2003). The heavy metal contamination in soil and water has increased exponentially during last few decades due to rapid industrialization, anthropogenic activities and modern activities and modern agricultural practices. (Kavamura and Esposito, 2010). Heavy metals in the topsoil are easily absorbed by crops and enter the food chain. On the basis of role in biological systems, heavy metals are classified as essential and non-essential heavy metal. Essential heavy metals like Co, Fe, Mo, Mn, Cu, Zn, and Ni are essential for normal plant growth, development, reproduction, physiological and biochemical functions where as various heavy metals such as Cd, Pb, As, Hg, and Cr have been considered as non- essential for physiological functions (Cempel and Nikel, 2006). Heavy metals are easily absorbed by root of plants and translocated to plant parts such as leaves, shoots, and edible part which leading to contamination of the food chain. (Clemens, 2006). Dietary intake of heavy metals poses risk to several diseases like cancers human and animals. (McLaughlin *et al.* 1999). The enhanced concentration of heavy metals exhibits toxic effects on plants such reduced plant growth, yield and quality. (Hall J.L. 2002). A common consequence of HM toxicity is the excessive accumulation of reactive oxygen species (ROS) and methyl glyoxal (MG), both of which can cause peroxidation of lipids, oxidation of protein, inactivation of enzymes, DNA damage and/or interact with other vital constituents of plant cells (Hossain *et al*., 2012).

Uptake and Translocation of Heavy Metals

The heavy metals are uptaken by plants through channel of its roots and foliar surface (Sawidis et al., 2001). The uptake and translocation of metals from the soil depends on different factors such as their soluble content in it, soil pH, plant growth stages types of species, fertilizers and soil (Sharma *et al*., 2006). The presence of heavy metals in soil creates competition for transportation of other metals abs nutrient elements. The roots uptake heavy metals from soil through passive or active transport against concentration gradients through carriers' proteins (Fergusson J.K. (1990). Metal ions enter into the root either through apoplastic or symplastic pathways. The movement of metal ions from root to shoot takes place through symplastic movements via xylem (Teater and Leigh 2000). The heavy metals are accumulated in vacuole, where their detoxifications take place in presence of organic acids.

Tolerance for Heavy Metal Toxicity in Plants

There are several sources of reactive oxygen species (ROS) production in plants like chloroplast, mitochondria, peroxisomes, apoplasts, endoplasmic reticulum, plasma membrane and cell wall. The O_2 is reduced to ROS (O_2-, H_2O_2, HO_2-, OH- $^1O_2$) through electron transfer reaction or energy transfer reactions (Halliwell B. (2006). OH- is capable of reacting with pigments, protein, lipids and DNA, leading to its denaturation.

Antioxidatative Mechanism in Plant Under Heavy Metal Stress

The superoxide dismutase (SOD), catalase (CAT), ascorbate peroxidise (APX), guaiacol peroxidise (POX), and glutathione reductase (GR) have importance role to reduce ROS level in cell. Under metal stress conditions the expression level of genes related to these enzymes are enhanced as well as activities of these enzymes also increased. The SOD acts as defense system to overcome the ROS concentration in cell. The SOD converts free radicals of oxygens to H_2O_2. The H_2O_2 is substrate for enzymes like APX and CAT. APX and CAT convert the H_2O_2. The APX also uses ascorbic acids as substrate, whose concentration is balanced through monodehydroascorbate reductase (MDHAR), dehydroascorbate reductase (DHAR) and GR in cell (Halliwell B. 2006).

Achievement for Heavy Metal Tolerance

Aluminium tolerance capacity in Brassica napus is increased through enhancement of SOD activity. The SOD gene of *Triticum aestivum* was cloned in *Brassica napus* through *Agribacterium* with CaMV355 promoter (The transgenic plants produce 2.5-fold SOD than wild type plants (Shamim and Pandey 2017). The heavy metal tolerant lines of sugar beets were developed through *Agrobacterium* mediated transformation of **Streptococus thermophilus** gene for λ- glutamyl- cysteine synthetase- glutathione synthetase (StGCS-GS). The StGCS-GS gene overexpressed in sugarbeet cells and enhanced its tolerance capacity for Cd, Zn, Cu (Liu *et al*., 2015).

Future Prospects

There is a need to identify the specific heavy metal tolerant genotypes which are able to mitigate heavy metal toxicity. Some metabolic pathways that produce specific metabolites from plant roots to overcome the toxicity. The overexpression of genes related to heavy metal toxicity like genes encoding for antioxidative enzyme, like phytochelatins and heavy metal transporters will helpful to develop plants which has elite property for tolerance against heavy metal toxicity. Such approaches are capable to enhance the crop production in heavy metal contaminated areas.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Citrus Microbiome

Article ID: 12109

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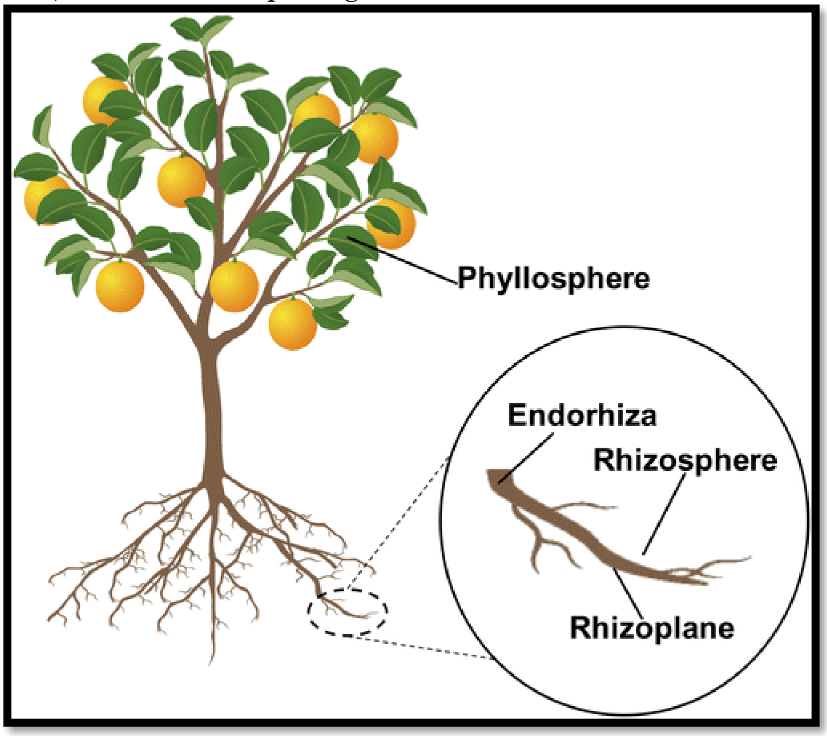
Introduction

Citrus is one of the major perennial fruit crops in the world. Basically, citrus is a mesophyte tree and called as fruit of godly tree. India is the 4th largest producer of citrus fruit in the world. It is, otherwise, called as Mexican lime, Kagzi lime, West Indian lime or Key lime. In India, locally it is called as Nimbu. Its chromosome number is 18 (2n=2X=18). However, many challenges are being faced by citrus production, *viz.*, nutrient limitation and diseases. There are major research endeavours to think the composition and function of the citrus microbiome and work on the citrus microbiome to identify various challenges in citriculture (**Wang *et al.*, 2017**). In this new era, rapid developments of multiomics technologies *viz.*, amplicon-based sequencing, shotgun metagenomics, metatranscriptomics, and metabolomics, the function and structure of plant microbiomes are more clearly demonstrated (**Song *et al.*, 2020**). In this popular article, we will summarize and discuss in detail the current scenario regarding the citrus microbiome.

The plant microbiome or phytobiome are the microbial groups linked with plants, which is comprised of a diversified microorganisms such as viruses, bacteria, archaea, fungi, oomycetes and nematodes. They may live externally on or internally in their respective host plant. Those live outside their host plants are either epiphytic (means living on the plant tissue surface) or rhizospheric (*viz.*, residing the first several millimeters away from the roots within the soil). Microbes that establish colonies inside their host plant, conversely are called endophytic microbes. The relationship of individual microbes with their plant hosts is divided into commensal, beneficial and pathogenic.



The root microbiome i.e., the root-associated rhizosphere, rhizoplane, and endophytic microbes, one focus of plant microbiome research, maintaining soil properties and protecting the host from pathogens which increases niche occupation and immunity performs many major functions, including assisting with nutrient uptake, promoting plant growth by producing plant growth hormones, cycling carbon & nutrients. (**Berendsen *et al.*, 2012**). The phyllosphere microbiome is considered as another focus of plant microbiome. Leaves as the major plant organs are responsible for photosynthesis and constitute the second largest plant microbial habitat compared with the root system, thus receives most of the attention of phyllosphere studies. However, flowers and fruit are the key as consumer end products and most importantly entry points of many pathogens.

The interplay between the microbiome and plant are highly complex and dynamic. The above said can be beneficial (mutualistic), neutral (commensalism), or detrimental (parasitic). As a consequence, the plant microbiome subsequently affects plant health and productivity. The plant microbiome induces or prime plant defends against a broad range of pathogens and insect herbivores. It also plays essential roles in disease-suppressive soils. Moreover, the plant microbiome is important factor in global biogeochemical cycles, participating significantly in biochemical cycling of the products of photosynthesis (**Turner *et al.*, 2013**). So, to interfere with plant disease development, promote plant production, and ease chemical inputs, leading to more sustainable agricultural practices, manipulation of plant microbiomes is necessarily required.

Rhizosphere Microbiome

Evaluations of the root microbiome related with citrus and its species using both cultivation and non-cultivated based methods have showed the development of bacterial phyla *Proteo bacteria* and *Bacteroidetes* in the rhizosphere as linked with bulk soils, whereas members associated with *Cyanobacteria*, *Firmicutes*, *Acidobacteria*, and *Actinobacteria* were declined (Trivedi *et al.,* 2010). The citrus rhizosphere was influnced by fungal phyla Ascomycota, Basidiomycota and barely, Glomeromycota; however, the judicious enrichment in the rhizosphere was only observed for genera distributed in Ascomycota (Xu *et al.,* 2018).

Additionally for bacteria, fungi and archaea, the plant-associated microbial communities consist other microbes *viz*., protists, nematodes and viruses (Leach *et al.* 2017; Mendes *et al.* 2013; Trivedi *et al.* 2020). Recent studies indicated that by predation effects and contribute to plant growth and fitness promotion, the protists can control the diversity and structure of the microbiome (Geisen *et al.* 2016; Xiong *et al.* 2020). Many species of nematodes from the citrus rhizosphere have been reported from Morphological and microscopic studies. (Eisvand *et al.* 2019; Mankau and Gaspard 1986). Most of the nematodes associated with the citrus rhizosphere owes to genera *Monoacrosporium, Agamermis, Alaimus, Aphelenchus, Hemicriconemoides, Diphtherophora, Nanidorus, Pratylenchus, Tylenchorhynchus,* and *Tylenchulus* (Campos-Herrera *et al.* 2013; El-Borai *et al.* 2003; Mankau and Gaspard 1986). However, the functions and consequences of these said denominations on the citrus host remain evasive. A targeted metagenomic-based thinking must be held, in the near future to explore microbes other than bacteria and fungi in the citrus microbiome.

Rhizoplane Microbiome

The rhizoplane (root surface) behaves as a crucial gateway which regulates microbial entry into the root. However, the citrus rhizoplane microbiome is still largely undiscovered compared with the citrus rhizosphere microbiome, partially inclining to the difficulty of the rhizoplane sample collection procedures, in which vigorous vibrating-based treatments are required and many fewer microbial cells can be collected than in the rhizosphere sample collection procedure (**Wang *et al.* 2020**).

Multiple bacterial genera associated with Proteobacteria (with Bradyrhizobium and Burkholderia being the two most dominant genera) shows a strong rhizosphere-to-rhizoplane improvement pattern. In vitro experiments shows that both Burkholderia strains directly inhibit the growth of multiple citrus pathogens *viz.*, *Phytophthora nicotianae, Alternaria alternata, Colletotrichum acutatum, Phyllosticta citricarpa* and *Phytophthora palmivora* and helps the citrus host resist other pathogens by inducing the systemic resistance of the citrus host. Nevertheless, culturomics and bioinformatics approaches might facilitate our thinking of how these plant-preferred microbes that are enhanced in the rhizoplane from the rhizosphere contribute to citrus health and fitness.

Endorhiza Microbiome

Recent studies on the citrus endorhiza microbiome were performed mainly via sequencing the 16S ribosomal DNA (rDNA) hypervariable regions or cultivation- based approaches, with surface-disinfected roots as working materials *Proteobacteria*, *Firmicutes*, and *Actinobacteria* are the most dominant phyla in the endorhiza microbiome of citrus plants, with beneficial genera such as *Burkholderia*, *Variovoras*, *Bacillus*, *Brevibacillus*, and *Paenibacillus* frequently reported, as revealed by both cultivation- and noncultivation-based studies **(Bai *et al.,* 2019).**

Until now, metagenomics or metatranscriptomics studies have not been performed for the citrus endorhiza or the so-called root microbiome, possibly because of the difficulties of removing host DNA and RNA from that of the microbiome, which hampers our understanding of the endorhiza microbiome. Under this circumstance, comparative genomic analysis between the root-adapted microbes and their non-plant-associated taxonomic-related relatives is a promising approach to reveal the functional attributes critical for the microbes for adapting within the root endorhiza (**Levy *et al.* 2018**); moreover, high-throughput gene mutation and screening methods such as randomly barcoded transposon sequencing can further identify the individual genes and the pathways involved in the root niche adaptation of a particular microbe (**Cole *et al.* 2017**).

Phyllosphere Microbiome

The phyllosphere niche is defined as the aboveground portions of a plant where microorganisms colonize. The microorganisms pioneering the phyllosphere are exposed to diverse biotic (e.g., insect visitations, and microorganisms introduced by wind or other carriers) and abiotic (e.g., rainfall, heat, and UV radiation) stresses and agricultural practices, in addition to immune response of the plant host. The citrus phyllosphere bacterial community is dominated by phyla *Proteobacteria*, *Firmicutes*, and *Actinobacteria*, which is similar to the citrus root-associated microbiome; however, the ratio between these phyla varies significantly among trees from different geographic locations, citrus cultivars, and health status. Moreover, the taxa *Bacteroidetes* was more copious in the citrus leaf microbiome than in the citrus root- associated microbiome. The studies coupled with functional microbiome studies will be important to understand the function of the microbiome on the leaf surface and inside the leaf, and how to utilize phyllosphere microbes to promote plant health and fitness.

Potential and Application of Manipulation or Engineering Citrus Microbiome

There is also evidence to suggest that plants recruit specific beneficial microbes to promote plant immunity. Harnessing the largely unexplored functional potential of the plant-associated microbiome has tremendous potential to expand the genomic capabilities of their host by improving nutrient uptake, enhancing tolerance to environmental stress, and providing protection against pests and diseases. In this context, microbiome engineering has recently emerged as an alternative to promote positive plant– microbiome interactions in order to improve plant fitness. A safer alternative with respect to environmental safety and even public health (e.g., avoid antibiotics contamination and ARG dissemination) compared with the aforementioned antibiotics treatments is presented by the microbiome engineering approach.

In recent years, in understating the makeup and functional potential of plant-associated microbiomes, significant progress has been made. Because microbiome engineering has been identified as a major route to increase plant resistance to biotic or abiotic stress, interest and investment in developing microbial inoculants to enhance these functions has recently surged. To effectively harness the microbiome, there needs a requirement of new approaches which recognize that microbes living in natural and managed systems typically do so as communities, but not as populations of single organisms functioning alone. These advances will open up approaches to rewire plant–microbiome interactions to activate specific members of microbiota to fix N_2, produce anti-biotics or hormones, chelate iron, or solubilize soil nutrients. These upcoming tools and technologies that allow us to engineer plant- associated microbiome are urgently needed to save citrus from the HLB crisis.

Conclusion

However, previous studies have provided good knowledge of the citrus microbiome, which includes taxonomic composition and functional potential across compartments, locations, and different disease conditions. But, the utilization of the citrus microbiome remains in its infancy. In the long run, we need to attain a system- level understanding of citrus microbiome, for improving citrus production and health via microbiome engineering. We have to think that the broad application of multiomics methods, network analysis, consortia of microbes, artificial intelligence, genome editing, and high-throughput culturing will significantly advance our understanding of citrus microbiome and further liberate the potentials of the citrus microbiome.

The citrus microbiome remains largely unexplored. Although the productive lifetime of citrus trees is usually less than 50 years, they can live for more than a century. The long lifespan of citrus likely leads to change in microbiome composition, which adapts to the changing environment and citrus physiology over time. Citrus is grown worldwide. For even more than 140 countries produce citrus, with more than half grown in subtropical regions. The wide variations in soil, temperature, rainfall, pH, citrus varieties, different disease challenges and production practices along with the worldwide distribution of citrus almost certainly is leading to a wide range of microorganisms comprising the citrus microbiome. As a consequence, we must aim to investigate the citrus microbiome at the global scenario.

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Impact on Plant Diseases and Pests Under Change Climate in Future

Article ID: 12110

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Summary

The prevailing weather conditions influence the behaviour of the insects and pests in many ways. The population and growth of the insects and micro-organisms are affected by the weather, especially which are regulated by extremes of temperature and rainfall in the field. It has been predicted that future climate change is likely to affect the production of crops negatively in low latitude countries, while effects in northern latitudes may be positive or negative. Climate change will probably raise the risk of food insecurity. Most of the organisms including humans depend upon weather in the short term and climate in the long term, these being highly important determinants of the distribution and abundance of all species including pests and pathogens.

Introduction

Climate is bound to change as the earth is ageing naturally, however, the most unexpected and unprecedented changes in pace are due to anthropogenic activities like environmental pollution, long-distance introduction of exotic species and urbanization, etc. At present, climate change is one of the biggest threats to mankind, and is the cause of nearly 0.4 million deaths per year worldwide and costing the world more than US$ 1.2 trillion (McKinnon et al., 2012).

The effects are being felt most keenly in developing countries like India, where loss to agricultural production from extreme weather associated with climate change is contributing to death from malnutrition, poverty and their associated diseases (Gautam, 2009). Climate change affects agriculture in a number of ways; including changes in average temperatures, rainfall and climate extremes (e.g., heatwaves), pests and disease outbreaks, ground-level ozone concentrations, atmospheric CO_2 and nutritional quality of foods (Porter et al., 2014).

In the field of agriculture, weather and climate affect crop production and quality as well as the dynamics of pests, diseases and their regulation by natural enemies; a regulation that mostly goes unnoticed by humans (DeBach, 1964). Several reports indicate that plant pathogens cause significant economic crop yield losses every year (Sharma et al., 2017). Oerke (2006) reported crop losses ranging from 25–50% depending on the crop. Briefly, this article focuses on the discussion of different aspects related to the effects of climate change on plant diseases and suitable remedies for their effective management.

Effect of Climate Change on Plant Diseases

Climate change is a major problem of concern for agriculture globally. As a result of climatic uncertainties, new pests have emerged, the crop cultivation practices have changed, and drought, hail storms and floods have created havoc around the world (War et al., 2016). Changes in the environmental conditions which are most likely to cause the northward extension of certain pests and diseases, rapid multiplication of pathogens per season, and a better adaptability to survive the winter, thus enhance their fitness, number and range. Further compounding the problem is that as farmers change their crops and cropping patterns to fit the changing climate, their crops will be exposed to new kinds of diseases and pests. However, it is also feasible that physiological changes in the host leads to greater disease resistance (Ho Won chung et al., 2009). The severity of plant diseases which are caused by bacteria, fungi, viruses and insects are expected to increase with global warming (Pautasso et al., 2012).

For example, the population of pests and other vectors that cause plant diseases are related to the interaction of different factors such as rise in temperature, increase in concentration of atmospheric CO_2 and changes in concentration of moisture (Chander et al., 2009). By 2050, as a result of possible climate shifts in the Indo-Gangetic Plains (currently part of the favourable, high potential, irrigated, low rainfall mega-environment) that accounts for 15% of global wheat production – up to 51% of its area might be reclassified as a heat stressed, irrigated, short-season production mega-environment (Duveiller et al., 2007). If this prediction proves to be correct, an elevation in spot blotch severity and incidence can be anticipated in wheat growing areas where the disease does not figure prominently today.

Adaptation Strategies for Climate Change

There is a need to integrate findings and insights from the physical and social sciences with knowledge from local farmers and land managers to provide guidance and suggestions to decision-makers for promotion of robust strategies, including cooperation of both public and private sectors. In addition to changes driven by socio-economic factors, farmers will have to adapt to changing climates in the coming decades by applying a variety of agronomical techniques that already work well under current climates, such as adjusting the timing of planting and harvesting operations, substituting cultivars and wherever necessary modifying or changing altogether their cropping systems (Rosenzweig et al., 2007). However, adaptation strategies vary with the agricultural systems, location and scenarios of global climate change.

At higher levels of adaptation, cropping systems and crop types could be changed altogether in addition to field management adjustments or cultivation areas could shift geographically, following the creation of new agricultural zonations determined by a changing climate (Reilly et al., 2003). Under warmer climates, crops would tend to mature faster, resulting in less time available for accumulation of carbohydrate and grain production. Therefore, by substituting current cultivars with genotypes requiring longer time to mature, yield potential under climate change may be restored to levels typical of current conditions. In addition to changing planting strategies and cultivar type, land management systems could be adapted to new climate scenarios. Shifts from rainfed to irrigated agriculture is the simplest way, although issues of water availability, cost, and com- petition from other sectors need to be considered (Tubiello et al., 2002).

Mitigation Strategies for Climate Change

Disease management strategies depend upon climate conditions. Change in climate will cause alterations in the disease geographical and temporal distributions and consequently control methods will have to be adapted to climate change scenarios. Changes in temperature and high precipitation can alter fungicide residue dynamics in the foliage and the degradation of products can be modified. Changes in plant morphology or physiology resulting from high concentration of CO2 in the atmosphere or from different temperature and precipitation conditions can affect the penetration, translocation and mode of action of systemic fungicides. Besides that, changes in plant growth and development can alter the period of higher susceptibility to pathogens that can determine a new fungicide application (Coakley et al., 1999). Therefore, some important mitigation strategies for managing plant diseases in respect of cli- mate change include:

1. Selection of resistant cultivars/varieties at elevated temperature.
2. New molecules with higher efficacy at increased temperature for disease management.
3. New forecasting model for prediction of appearance of diseases.
4. Change of date of sowing to avoid cause of epidemic.
5. Selection of bio-agents having wide range of temperature adoptability.
6. Disease management through integration of all the existing technologies.
7. Efficient tillage practices for disease management.

Conclusion

Changing disease scenarios due to global climate change have highlighted the need for better agricultural practices and use of eco-friendly methods in disease management for sustainable crop production. In the changing climate and shift in seasons, choice of crop management practices based on the existing situation is essential. In such situations, weather-based disease monitoring, inoculum monitoring, especially for soil-borne diseases and rapid diagnostics would play an important role. There is a need to adopt new approaches to counter the resurgence of diseases under climate change. Integrated disease management strategies should be developed to decrease dependence on fungicides (Gautam and Bhardwaj, 2011). Other multipronged approaches include healthy seeds with innate forms of broad and durable disease resistance and intercropping systems that foster refuges for natural biocontrol organisms. Also, monitoring and early warning systems for forecasting disease epidemics should be developed for important host-pathogens which have a direct bearing on the earnings of farmers and food security at large (Boonekamp, 2012). Use of botanical pesticides and plant-derived soil amendments help in mitigation of climate change, because they help in the reduction of nitrous oxide emission by nitrification inhibitors such as nitrapyrin and dicyandiamide (Pathak et al., 2010).

There has been only limited research on the effect of climate change on plant dis- eases under field conditions or disease management under climate change. However, some assessments are now available for a few countries, regions, crops and particular pathogens which concern with food security. Now, emphasis must shift from impact assessment to developing adaptation and mitigation strategies and options. First, there is need to evaluate under climate change the efficacy of current physical, chemical and biological control strategies, including disease-resistant varieties, and second, to include future climate scenarios in all research aimed at developing new tools and methods. Disease risk analyses based on host–pathogen interactions should be managed and research on host response and adaptation should be conducted to understand how an imminent change in the climate could affect plant diseases.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Fertilizer Requirement / Water Requirement in Rice Under Temperate Conditions

Article ID: 12111

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Preparation of Nursery

For an area of 1 ha (20 kanals) land a nursery area of 1 kanal is sufficient to provide healthy seedlings. Prepare well puddle weed free nursery seed bed.

Plough the nursery area 2-3 times to bring the field so that 2-3 cm layer of water is maintained in the nursery bed.

Temperature fluctuation during the month of April and first fortnight of may due to incessant rains can lead to stunted and week rice nursery and even complete failure of nursery. Therefore, protected nursery can be an alternative to save nursery from climatic vagaries.

Protected Nursery

Nursery is sown in strips of im wide and this area is covered with polythene sheets which is placed on fixed willow sticks in such a manner that it looks like low tunnel. The polythene sheets on both sides are covered with dry soil or pebbles. During day time (sunny days) remove polythene by rolling.

Keep the nursery covered with polythene on cloudy/ rainy day. During night hours for initial 10-15 days, keep nursery covered. Once nursery is fully established, cover it only when required depending upon the weather conditions.

Sowing of Seeds / Nutrient Management

Seeds should be soaked in water for 24 hrs. Broadcast pre-germinated seeds uniformly in the seed bed and maintain 2-3 c m water till pre-germinated seeds are established. Avoid incorporation of undecomposed FYM at the time of nursery bed management. Apply **275-gram** urea, **450**-gram DAP, and **200**-gram MOP per Marlas (25m^2). Fertilizer is recommended to be incorporated in the nursery bed during soil preparation. If algal growth is visible apply copper sulphate @ 0.5g + lime @ 0.5 g/liter of water and drench it after drainage of previous water. In case yellowing is noticed, drain out water for few days and apply 1 Kg N/ 100 sq. M (4 marlas) of nursery area. FYM @ 10 t/ ha (500 kg / kanal) should be incorporated in the soil at final preparation of land.

Varieties Planted in Lower Belts

Urea @ 4 kg / kanal, DAP @ 6.5 kg/kanal, MOP @ 2.5 kg/ kanal (as basal) and zinc sulphate @ 0.5-0.75 kg / kanal
Urea as top dose 1st split @ 3.25kg/ kanal, 2nd split @ 3.25 kg.

Varieties Planted in Higher Belts

Urea @ 1.8 kg / kanal, DAP @ 6.5 kg/kanal, MOP @ 2.5 kg/ kanal (as basal) and zinc sulphate @ 0.5-0.75 kg / kanal.
Urea as top dose 1st split @ 2.25kg/ kanal, 2nd split @ 2.25 kg.

Varieties Planted in Water Logged Areas

Urea @ 2.35 kg / kanal, DAP @ 6.5 kg/kanal, MOP @ 2.5 kg/ kanal (as basal) and zinc sulphate @ 0.5-0.75 kg / kanal
Urea as top dose 1st split @ 2.45kg/ kanal, 2nd split @ 2.45 kg

For varieties recommended for lower belts nitrogen should be applied in three splits. i.e 1/3rd as basal, 1/3rd at **Active Tillering** and 1/3rd at **Panicle Initiation Stage**. Full dose of P_2O_5, K_2O and $ZnSO_4$ be applied as basal dose.

Water Requirement Stage Wise in Transplanted Rice

Stage of Crop	Depth of water (cm)	Advantages in maintaining the recommended depth of water
1 At Transplanting 2 After Transplanting 24-48 hrs 3 During Tillering 4 Midseason Drainage	Shallow (2-3cm) Deep (5-7 cm) Shallow(2-3cm) -----	• Shallow transplanting is possible • Helps in good tillering • Better Establishment of seedlings • Quick development of new roots • Reduction in transpiration • Excess water reduces tillering • Stimulate rooting • Check unproductive shoots • Non accumulation of toxic substances • Drains excess nitrogen • Sterility percent reduced • Supply of oxygen to elongate internodes prevents excess mineralization • Prevent lodging • Avoids zinc deficiency
Reproductive stage Panicle emergence, Booting, heading, flowering Ripening Stage (21 Days after full flowering) Milk stage, Dough Stage	Deep (5-7 cm) Drain the field gradually	• Moisture Stress • Impaired panicle growth • Increased sterility • Excess water • Delay in heading • Stem weakens a lodging • Early withdrawl • Increase of immature grains • Broken grains • Late Withdrawal • Lodging

Note: Drain the field to a very thin film of water a day before top dressing with nitrogen re flood after 48 hrs to reduce nitrogen loss.

Critical Stages of Water Requirement

Critical stage refers to a stage when water scarcity or deficit of water causes comparatively greater reduction in yields which cannot be made by favourable water supply at earlier or later stages. Hence water deficit during these stages should be avoided.

1. Active tillering stage: 30% yield reduction.
2. Reproductive stage: panicle initiation, flowering: 50-60 % reduction.

E-ISSN: 2581 - 8317

Drudgery Reducing Technologies of Farm Women in Agriculture

Article ID: 12112

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1	Single wheel hoe	It is used for weeding and interculture of vegetables and other crops sown in rows. It is a widely accepted weeding tool for weeding and interculture in row crops. It is manually operated equipment for weeding and interculture in upland row crops spaced above 240 mm. It consists of wheel frame, V-blade with tyne and handle. Weeds cutting and uprooting are done through push and pull action of the unit.	
2	Double wheel hoe	It is manually operated equipment for weeding and inter-culture in upland row crops in black soil region. It consists of twin wheels, frame, V-blade with tyne, U clamp, scrapper and handle. Weeds cutting and uprooting are done through push and pull action of the unit.	
3	Cono weeder	The cono weeder is used to remove weeds between the rows of paddy crop efficiently. It is easy to operate, and does not sink in the puddle. The weeder consists of two rotors, float, frame and handle. The rotors are cone frustum in shape, smooth and serrated strips are welded on the surface along its length. The rotors are mounted in tandem in opposite orientation. The float controls working depth and doesn't allow rotor assembly to sink in the puddle. It is operated by pushing action.	
4	Groundnut decorticator	It is a manually operated equipment to separate kernels from groundnut pods. The unit consists of frame, handle, oscillating arm sieve with oblong hole. The pods are feed in batches of 2 kg and crushed in between concave and oscillating arm having cast iron/ nylon shoe to achieve shelling.	
5	Fertilizer broadcaster for women	It is hand operated fertilizer broadcaster for women .It weighs only 3.5 kg. Its tank capacity is 7.5kg, and Swath width- 5 m. an area of 1.1 hectare can be broadcasted by it in one hour.	

6	Hanging type Grain Cleaner	It is a simple hanging grain cleaner. Around 225 kg of grain can be cleaned per hour as against the conventional cleaning of 25 kg per hour	
7	Hand Sprayer	The hand sprayer is a small capacity pneumatic sprayer. For spraying, the tank is usually filled to three-fourths capacity and pressurized by air pump. The compressed air causes the agitation of the spray liquid and forces it out, on operation of the trigger or shut off type valve.	
8	Sickles	Sickle is one of the most common hand tools used for harvesting of the crops, grass and cutting of other vegetative matters. For cutting, the part of the plant to be cut is held in one hand and sickle operated with other hand. Cutting is achieved by imparting translatory and rotary movement to the blade around the point of cut.	
9	Plucker	The tool is ergonomically designed. The plucker consists of two arms hinged together, cutting blades joined to open ends of arms and two rings joined to the arms. Panicles are cut individually using this tool. The operator is spared of drudgery, discomfort and itching to skin of his hands, which are associated with conventional method of manual plucking without any aid. It fits in to the hand properly with the help of two rings, one over thumb and another over index finger.	
10	Pedal Operated Thresher	It consists of wire-loop type threshing cylinder, power transmission system, mild steel sheet body and foot pedal. On pressing the pedal the threshing cylinder starts rotating. For continuous rotation of the cylinder, the pedal is lowered and raised repeatedly. For operation, paddy bundle is held in hands and ear head portion of the crop is placed on the rotating cylinder. The wire-loops hit the ear heads and grain get detached from the rest of the crop.	
11	Sugarcane Stripper	It is used for stripping of leaves and detopping of cane after harvest of sugarcane. The stripper works by separating and pushing the leaf sheaths away from stalk. A knife is welded on the stem of the stripper for detopping of canes and for cleaning roots. The capacity of this machine is about 46 kg/hr.	 

12	Paddy winnower	This machine is easily operated and very useful for women farm workers. It consists of main frame, handle, gear mechanism, volute case, fan, hopper, outlets for clean grain and chaff. This machine can be operated by women worker by using hands in standing posture. Two women workers are required for operation of this machine, one woman operates the machine and other woman feeds the hopper and separates the cleaned grain. The machine can be easily operated by women while seating on chair or stool.	
13	Fruit Harvester	It is used for plucking of fruits from orchard trees. It consists of main body of PVC having cylindrical shape. The upper end of the body is closed and fixed with two fingers cut in V-shape and with sharp blades. An opening is provided on the body for entry of the fruits to be harvested. The length of the cutting blade was increased from 30 mm to 70 mm to increase the comfort of the worker. The capacity of this machine is about 420 fruits /hr.	
14	Groundnut stripper	The groundnut stripper consists of a square frame of vertical legs and a horizontal strip of expanded metal fixed on each side of the frame in the form of comb. The stripping of the pods is accomplished by drawing a handful of vines across the comb with a slight force. The structure facilitates its use by four women simultaneously. The frame was provided with telescopic support legs which enable the subjects to adjust the height of the frame from the ground level to suit their convenience to avoid postural discomfort. Also the hitting of the elbow against the abdomen while stripping is eliminated.	
15	Tubular maize Sheller	It is a hand operated tool to shell maize from dehusked cobs. The unit consists of galvanized mild steel pipe with four tapered fins riveted to its inner periphery. The Sheller is held in left hand, a cob held in right hand is inserted into it with forward and backward twist, to achieve the shelling. Octagonal designs are also available.	

The Pics Bag, A Technology for Enhancing Storage Facilities of Crop Produce

Article ID: 12113

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Postharvest management of agricultural products is a significant challenge in developing countries. Postharvest management, including handling and storage, play a vital role in keeping agricultural commodities safe from deterioration. Important staple crops such as maize, wheat, rice, and beans are susceptible to storage losses mostly due to insect pests. There are several grain storage techniques, including traditional/local methods, pesticides, and hermetic systems. The storage systems' most important feature is to preserve the integrity of the grain for a given period with minimal loss in quality and quantity. Hermetic technologies as an alternative to traditional and chemical control methods have gained significant interest among farmers, the private sector, governments, and development agencies. Hermetic technologies owe their effectiveness to the airtight conditions created during storage. Biological processes such as respiration and metabolic activities are driven mostly by the presence of insects and other biological activities that lead to the depletion of oxygen and release carbon dioxide inside hermetic containers.

The post-harvest management and processing technology of cereals, pulses, oilseeds, fruits and vegetables are under development. The post-harvest losses of cereals, pulses, oilseeds are **10-20 per cent** but the losses of fruits and vegetables in India vary from 20-30 per cent of the production. India's post-harvest fruit and vegetable losses are **over Rs 2 lakh crore annually**, owing to inadequate cold storage facilities and lack of proper food processing units. More than 12 million small and marginal farmers in developing countries adopted PICS technology for storage of farm produce.

Small and marginal Farmers are getting less income from cereal and pulse crops due to less storage facilities to store grains till the remunerative price attain in market. Storage of grains from field crops is major problem still today in India, due to lack of awareness on storage systems and facilities. Insect pests have been a serious problem threatens the livelihood of small-scale farmers and most commonly found insect was T. Castaneum, R. Dominica and C. Cephalonica. Hermetic storage bags are best solution to this farming group to store their grains at depleted oxygen levels and enhanced carbon dioxide levels to prevent growth of insects in grains. Among the advantages of hermetic storage, the generation of Modified Atmosphere (MA) eliminates the need for chemical treatments, fumigants, etc. These structures may help in reduction in moisture migration from the environment to the grain, protection from rodents, reducing losses of germination and vigour of the grain. Hermitic storage system works by preventing exchange with external moisture and gases. Insects require oxygen for breathing. Oxygen levels in the grain bulk reduction during respiration (while sealed hermetically). It is in line with raising levels of carbon dioxide. In addition, the impact of depleting oxygen was greater than accumulation of carbon dioxide. In the process of this, insects avoid eating, rising and reproducing. Disruption of the respiratory cycle leads to a reduction in the values of the respiratory quotient (the ratio of carbon dioxide to the amount of oxygen used) as the levels of oxygen reduction over time. Population thus remains low, inactive and inevitably dies (of desiccation or asphyxiation). In addition, fungal growth is impeded by hermetic storage bags.

The Purdue Improved Crop Storage bags (PICS) is a simple, low-cost storage method for preserving grain without using insecticides has been developed by Purdue University in 2014. PICS technology is a storage solution for smallholder farmers made of a three-layer bag that includes two liners and an outer woven layer. By creating a hermetic (airtight) seal inside the bag, PICS bags eliminate insect pests, stop mold growth, and maintain grain and seed quality. PICS bags were first developed and disseminated in West and Central Africa for cowpea (black-eyed pea) storage. Later, the bags were tested and disseminated for the storage of other crops including maize, rice, common beans, peanuts, wheat, sorghum, pigeon peas, mung beans, and other dry grains.

The use of PICS bags to store grains provides an opportunity to: (i) improve food security by allowing farmers to store grain or other foodstuffs through the lean season when supply is low, (ii) increase incomes of millions of smallholder farmers by providing the flexibility to store grain until prices are higher, and (iii) improve health by mitigating the impact of afflatoxin while reducing insecticide use. The PICS bags also help farmers to preserve their seed for planting, thus increasing availability and improving affordability and other health problems. The PICS bag, which secures crops, is also a lever for the fight against poverty and the sustainable improvement of producers' incomes. The adoption of the PICS technology by smallholder farmers will also provide job opportunities for the country's vulnerable youth.

AGRICULTURE & FOOD: E-NEWSLETTER
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E-ISSN: 2581 - 8317

Production Technology of Kharif Onion

Article ID: 12114

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Introduction
Onion is mainly cultivated as a rabi season crop in India. The produce from rabi crop cannot be stored beyond October due to sprouting of bulbs in storage. So, the prices of onion during this period remain high due to limited production of off-season onion and heavy transportation charges. The only way to stabilize the price of onion and fulfill the consumers demand is to increase the productivity of kharif onion. The kharif onion production is highly vulnerable to erratic monsoon and cloudy weather which creates problem of foliar as well as soil-borne diseases. Therefore, kharif onion plays a very crucial role in controlling the market price in our country.

Climate
In tropical and sub-tropical areas, onion is grown as a short-day crop and requires 25-30^{0}C temperature and 11-12 hours day length. Temperature range of 20-25^{0}C is found to be optimum for better seedling growth.

Soil
Light, friable and highly fertile soil is found to be optimum for onion cultivation. Sandy to sandy loam soil is generally recommended for kharif onion cultivation.

Seed Rate
8-10 kg seeds are sufficient for one hectare area.

Varieties
A good crop yield depends upon selection of proper varieties suitable for the environmental condition. Researches revealed that varieties like Arka Kalyan, Arka Niketan, Pusa Madhavi, Agrifound Dark Red, N-53, Baswant-780, Bhima Red, Bhima Super, NRCWO-1, NRCWO-3 and NRCWO-4 perform better and produce high yield under kharif cultivation.

Nursery Management
The seeds for kharif onion are usually sown in May-June. Raising of healthy seedlings is very difficult due to scorching heat and lack of irrigation water in summer which resulted in high mortality. Further, after the onset of monsoon, there is problem of water stagnation and high incidence of diseases. Before sowing, seeds of selected varieties are treated with captan or thiram at the rate of 3g/kg of seeds. Irrigation is provided through drip or sprinkler or manually with a rose cane. It is recommended to use 50% agri shade net or hessian cloth for shading over nursery beds during summer to protect the young seedlings from scorching sunlight and to ensure rapid and higher seed germination. The shade net should be removed after 40-45 days to avoid etiolation and lanky growth.

Transplanting
The transplanting time of kharif onion is different in kharif onion producing states which starts from first week of July to the end of august. Flat beds should be avoided to prevent water logging during kharif season. Broad bed furrow (BBF) is mainly recommended for kharif onion production because the excess water can be drained out through the furrows.

Manures and Fertilizers
Leaching and runoff losses are high due to heavy rainfall during kharif season. Application of 15 tonnes of well decomposed FYM or 7.5 tonnes of vermicompost is applied at the time of final land preparation. The recommended dose of fertilizers for kharif onion is 75 kg nitrogen, 40 kg phosphorus, 40 kg potassium per hectare. Along with this 30 kg of sulphur per hectare may be applied for enhancing the yield as well as

quality of biulbs. Full dose of P2O5, k2O and one-third of nitrogen is applied as basal dose. Remaining two-third of nitrogen is provided in two split doses at 30 and 45 days after planting.

Weed Management

Weed management during kharif is the most serious problem which limits the crop growth and yield. Monocot weeds are found more during kharif cultivation. Yield loss due to weed have been reported to an extent of 10-70%. Pendimethalin @ 2ml/lt of water after seed sowing controls the weed growth upto 30 days. After transplanting of seedlings or just before transplanting oxyflurofen @ 1.5-2.0 ml/lt of water may be sprayed to check the weeds upto 30-35 days and after that hand weeding should be done.

Harvesting

Generally, onion crop should be harvested after 50% top fall, which is an indicator of crop maturity. However, in kharif season, bulbs take 90-110 days to attain maturity but they remain in active stage and there will not be any top fall. Bulb shape, size and development of pigments is taken as an index of maturity. When this condition arrives, top fall can be induced mechanically by rolling an empty barrel two or three days before harvesting. Harvested bulbs are cured for three to four days in field itself to enhance the shelf life of the bulbs.

Conclusion

Our farmers need to enhance their productivity of onion production in order to obtain maximum benefit of high prices. This can be achieved by adopting scientific production technology like selection of suitable varieties, timely sowing of seeds in nursery and transplanting of seedlings, proper management of weeds and diseases.

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Roles of Jasmonic Acid in Alleviating Abiotic Stresses in Plants

Article ID: 12115

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Introduction

Plants as immovable organisms sense the stressors in their environment and respond to them by means of dedicated stress response pathways. In response to stress, jasmonates (jasmonic acid, its precursors and derivatives), a class of polyunsaturated fatty acid-derived phytohormones, play crucial roles in several biotic and abiotic stresses. As the major immunity hormone, jasmonates participate in numerous signal transduction pathways, including those of gene networks, regulatory proteins, signaling intermediates, and proteins, enzymes, and molecules that act to protect cells from the toxic effects of abiotic stresses. As cellular hubs for integrating informational cues from the environment, jasmonates play significant roles in alleviating salt stress, drought stress, heavy metal toxicity, micronutrient toxicity, freezing stress, ozone stress, CO_2 stress, and light stress. Besides these, jasmonates are involved in several developmental and physiological processes throughout the plant life.

Jasmonic Acid Signalling Under Salt Stress

Salinity stress has both osmotic and cytotoxic effects on plant growth and development. The endogenous JA content was increased in A. thaliana, tomato (*Lycopersicon esculentum*), and potato (*Solanum tuberosum*) after salt treatment. Transcript profile analysis of stressed sweet potato revealed that during salt stress JA level was significantly increased to cope with the effect of salt stress. The JA content increased immediately and persistently in the salt-sensitive plants, whereas the changes were not significant in the salt-tolerant ones. Exogenous MeJA increased the tolerance of the black locust tree (*Robinia pseudoacacia*) to salt stress by increasing the activities of superoxide dismutase (SOD) and ascorbate peroxidase (APX). These finding were similar to those of Faghih *et al*., who found that MeJA enhanced the activities of the APX, peroxidase (POD), and SOD enzymes. These lines of evidence suggest that JAs can alleviate salt stress by increasing the endogenous hormones and the antioxidative system.

Jasmonic Acid Signalling Under Drought Stress

Drought stress or water deficit decreases turgor pressure, increases ion toxicity, and inhibits photosynthesis. It has been reported in several studies that JA signaling pathways are associated with the alleviation of drought stress. The increase in the endogenous JA content was rapid and transient in A. thaliana and citrus (*Citrus paradisi* × *Poncirus trifoliata*) immediately after drought stress, but the content decreased to the basal level with prolongation of the stress. MeJA treatment could improve the drought resistance in peanut (*Arachis hypogaea*), rice (*Oryza sativa*), soybean (*Glycine max*), and broccoli (*Brassica oleracea*) plants. The application of exogenous MeJA not only increased the total carbohydrate, polysaccharide, total soluble sugar, free amino acid, total proline, and protein contents, but also the activities of catalase (CAT), POD, and SOD in maize plants (*Zea mays*). In the broad bean (*Vicia faba*) and barley (*Hordeum vulgare*) plants, MeJA increased their abilities to resist drought by regulating stomatal closure. MeJA also increased the drought resistance of cauliflower (*B. oleracea*) by activating the enzymatic (SOD, POD, CAT, APX, and glutathione reductase) and nonenzymatic (proline and soluble sugar) antioxidative systems. Therefore, MeJA effectively improves the drought tolerance of plants by increasing the organic osmoprotectants and antioxidative enzyme activity.

Jasmonic Acid Signalling Under Heavy Metals Toxicity

Heavy metals can mimic the essential mineral nutrients and generate ROS. Several studies have revealed that JA signaling pathways are associated with heavy metal toxicity. Exogenous MeJA could alleviate the cadmium-induced damage in soybean (*G. max*), *A. thaliana*, European black nightshade (*Solanum nigrum*), chili pepper (*Capsicum frutescens*), and mangrove (*Kandelia obovata*) plants by increasing the activities of

SOD, APX, and CAT. MeJA mitigated the toxicity of boron in the sweet wormwood (*Artemisia annua*) by reducing the amount of lipid peroxidation and stimulating the synthesis of antioxidative enzymes. In *B. napus*, oxidative stress was minimized by MeJA through the induction of the expression of genes encoding antioxidants and secondary metabolites. Therefore, the exogenous application of MeJA effectively alleviates heavy metal damage by increasing the levels of antioxidative enzyme activity and secondary metabolites.

Jasmonic Acid Signalling Under Micronutrient Toxicity

Several reports have suggested that JAs can protect plants from the effects of micronutrient toxicity. A high boron concentration is detrimental to plant growth and development as reported in the apple (*Malus domestica*) root stock, wheat (*Triticum aestivum*), barley (*H. vulgare*), and tomato plants. Treatment with exogenous MeJA could counter the boron toxicity in plants by activating the antioxidative defense enzymes (CAT, POD, and SOD) and inhibiting lipid peroxidation. JAs also play a crucial role in plant defense responses against lead (Pb) stress. JA showed a reduction in Pb uptake and increased the growth of tomato plants when seeds were primed with JA.

Jasmonic Acid Signalling Under Freezing Stress

Low temperature or cold stress causes extracellular ice crystal formation and cell dehydration. JA signaling plays a prominent role in the adaptation of plants to cold stress. The expression of the MYC TFs and several cold-responsive genes (MaCBF1, MaCBF2, MaKIN2, MaCOR1, MaRD2, MaRD5, etc.) was induced after the cold storage of bananas (*Musa acuminata*). MeJA could alleviate the cold stress in the tomato, loquat (*Eriobotrya japonica*), pomegranate (*Punica granatum*), mango (*Mangifera indica*), guava (*Psidium guajava*), cowpea (*Vigna sinensis*) plant, and peach (*Prunus persica*) by increasing the synthesis of antioxidants and the activation of some defense compounds (e.g., phenolic compounds and heat shock proteins). These results suggest that JAs can mitigate cold injury through their promotion of the active defense compounds and the antioxidative system.

Jasmonic Acid Signalling Under Ozone Stress

Ozone generates ROS that cause lesions and induce programmed cell death in plants. In wild-type Arabidopsis, the JA content was found to be significantly increased after ozone treatment. The spread of programmed cell death caused by ozone could be inhibited by exogenous treatment with MeJA. Moreover, the hybrid poplar (*Populus maximowizii* × *P. trichocarpa*) and tomato (*L. esculentum*) showed reduced sensitivity to ozone after exogenous MeJA treatment. Elevated ozone activated the JA pathway in tomato plants which significantly up-regulated the emission rates of volatile compounds for the protection of plants from natural enemies.

Jasmonic Acid Signalling Under Light Stress

Fewer reports are available about the effects of light and the JA signal on plant growth and development. In several studies, the JA signalling pathways in Nicotiana and Brassica species were initiated by the JA biosynthesis induced by UV-B treatment, which increased the defensive mechanisms of the plants. JA signalling had an effect on blue light-mediated light morphogenesis in *A. thaliana* and tomato (*L. esculentum*) and on red light/far-red light-mediated photomorphogenesis in *A. thaliana* and rice (*O. sativa*).

Jasmonic Acid Signalling Under CO_2 Stress

There are few reports about the JA signal transduction pathway in plants under CO_2 stress, however, these reports have varied for various plant and insect species. Ballhorn *et al.*, reported that in lima bean (*Phaseolus lunatus*), the concentration of MeJA and cis-JA was increased at a high concentration of CO_2 (500, 700, and 1000 ppm). An elevated level of CO_2 (750 ppm) increased the defense mechanism of tomato plants against nematode by activating the JA- and SA-signaling pathway. The elevated level of CO_2 also increased the JA and main defense-related metabolites in tobacco but decreased in rice.

Conclusion and Way Forward

JA and its derivatives play crucial roles in the defense and resistance of plants in response to biotic and abiotic stresses. The roles of JAs in the plant defense responses and in growth protection provide a direct way of alleviating the stresses. In the presence of abiotic stresses, JAs induce tolerance chiefly by activating the plant's defense mechanisms, which mainly involve the antioxidative enzymes and other defensive compounds. Future studies will pinpoint how different environmental signals are perceived by plants in the various components in the signalling pathways and the biosynthesis of the JAs, especially in the initiation and establishment of cooperation between the TFs and JAZ repressors during JA signal transduction. Future studies will also elucidate the molecular mechanisms of JA movement through the transporter, resource allocation between growth- and defense-related processes, synergistic or antagonistic interactions between JA and other hormonal signalling pathways. Such works will expand our understanding of the molecular mechanisms underlying the actions of JA against biotic and abiotic stresses.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Book Review of Horror, Loss & Hope: The Emperor of All Maladies

Article ID: 12116

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This year marks a decade since Siddhartha Mukherjee, an Indian-American Physician, and oncologist won the prestigious Pulitzer Prize in the General Non-Fiction category for his book "The Emperor of All Maladies: A Biography of Cancer". This particular book is recommended to all who are either curious about the 'Unspeakable Disease' or are looking for an engaging non-fictional read in these troubling times. The book is written from the perspective of an onlooker, a storyteller who tells the story of once the deadliest disease on the planet 'The Big C' i.e., Cancer.

The title of the book in itself tells a great deal of how the book is going to be. The book has presented to the readers as a biography rather than a history of Cancer precisely to make us understand the disease not as an enigma that even scientists of the highest order cannot solve but as a living and breathing character. The infuriating proposition from Mukherjee is, "Cancer cells grow faster, adapt better. They are more perfect versions of ourselves." This proposition may seem unfair but then again, the book will remind you so very often that life is meant to be unfair and nobody said that it would be a fair game.

Mukherjee at the very beginning reveals the reason why he decided to write the book. He reveals in the prologue of the book, that the book started as an attempt to answer few questions on cancer like how old is cancer? Where are we in the "war" against cancer? Can this war ever be won? Although he admits that he had a hunger for the history of cancer, he also confesses that he did not possess the prowess to envision it at that time. But with time he understood the craft of presenting historical facts in such a manner that readers from any and every background could understand this disease.

In the first few chapters Mukherjee takes us through the world of possibilities. Possibilities of beating this dreaded disease from the perspectives of different therapeutic approaches. Possibilities that emerged in the past from the efforts of numerous scientists and doctors and surgeons. The first few chapters provide us an overview of their experiments, breakthroughs, along with the risks and failures they had to face to get us to the point where we stand today in our 'war against cancer'. One of the very first stories that he presents in the book is that of Sidney Farber, the father of modern chemotherapy. Mukherjee in the second and third chapters of the book takes us through the whole journey of how chemotherapy came into being by means of experiments and its initial disastrous fallout. In the story of Sidney Farber, we come across a sense of helplessness, a sense that Mukherjee explains doctors and especially oncologists feel every single day. But the story of Farber is not there in the book to make the readers feel helpless but it is to provide them with a sense of hope. The sheer will and grit of Farber to not give up when one "antifolate" after another from his friend 'Yella' (Yellapragada Subbarow, a path breaking biochemist of Indian origin who apart from developing first chemotherapeutic agents like PAA, Aminopterin, Methotrexate, also purified ATP and Creatine) failed and yet he showed the courage to go on. The story of Farber and his experimental antifolates is a true testament of the popular adage, "Success is not final and failure is not fatal, it is the courage to go on that count".

The book contains stories of patients, patients who have fought against this horrible disease and won. But you will find that the book contains more horrors and defeats than of hope and win. These particular portions where you read about the battles of patients against the most relentless and insidious enemy of all human diseases, will be an emotional one but then again it is meant to be that way. For example, you will learn about Robert Sandler (to whom Mukherjee dedicated his book along with everyone who came before and after him), a two-year-old child who received the first chemotherapeutic agent, in the same chapter as that of Sidney Farber. Sandler a two-year-old lost his battle to cancer after showing some improvements following treatment with first antifolates from Farber. But unlike Farber's story that provided the readers with hope, the story of Sandler is a story of defeat. The story of Sandler is likely to make the reader feel sad and angry and fill them with despair. To some the story may generate deep feelings about their god and faith and maybe they will question their faith (we certainly did) as to why a two-year-old had to die? What could have the innocent life had done to meet his end at the age of two? TWO? Stories like that of Sandler are hard and warrant emotional response from the readers. Many may even question why these stories are given a space in a book which is otherwise a scientific document on a disease. The answer is, Mukherjee kept these real-life stories in the book precisely to invoke your emotions so that the stories of failure, of misery and of helplessness may motivate you. The stories of defeat are there to help you find the mast of courage needed to sail through the sea of despair that surrounds this deadly disease.

But the book is about cancer not about Sandler or Farber or anyone else. Hence, it is important to discuss about the scientific approach that has been adopted in writing this book. The book is a very well-researched one as it left no stones unturned in its quest to provide the reader with a complete profile of "The Distorted Version of Ourselves". Mukherjee has provided us with ample historical background on the disease from its first medical description in an Egyptian text originally written in 2500 BC to the genesis of present-day therapies dealing with cancer which include Chemotherapy, Surgical therapy, Radiation therapy, Immunotherapy. He also describes in lucid terms the limitations of these therapies so as to not give away any false sense of hope to any of his readers. In each of the six parts of the book you will find mentions of scientific articles and journals and writings that have provided Mukherjee with ample scientific material to put together a heavily detailed scientific writing on cancer. Yet, the book is not a sesquipedalian scientific prose documenting cancer; it is as Mukherjee put it a 'story of cancer'.

The book in some part provided insights into the mind of cancer cells. How the cells mutate to evade even the most potent therapeutic agents. The books explain how the mutations of our otherwise normal cells can have roots in our daily lifestyle, our food habits, smoking habits, etc which in turn may progress to developing malignancy. Mukherjee also shed light on the fact that in cases some cancers, family history (hereditary genetic cause) can contribute to developing cancer. Mukherjee also explains in great detail the importance of screening for malignant cells. He emphasised on the fact that what makes most forms of cancer curable today is preventive measures. He dedicated the fourth part of the book to explain how in case of cancer 'Prevention is cure'.

Towards the end of the book Mukherjee presents us with a future. A future where Atossa, the Persian queen who died of breast cancer will have survived. Mukherjee describes how genomic analysis of cancer cells will direct the course of therapy in the near future. He presents us with facts and not fiction as to why he believes that by 2050 most types of cancers will have definitive treatments based on the genomic profiles of the patients. It surely is a future that we all hope for and with recent advancements in therapeutics, the future surely looks bright.

At the end of the book Mukherjee describes the fate of one of his patient Germaine Berne, he describes how this young psychologist fought cancer "obsessively, cannily, desperately, fiercely, madly, brilliantly, and zealously" only to discover the truth, the essence of "War Against Cancer", "that to keep pace with this malady, you need to keep inventing and reinventing, learning and unlearning strategies". We wish you to read this particular book because you will need it, through this book you will understand why Cancer stories are not mere stories, why they matter and why they are inspiring albeit emotional if not highly thought-provoking. Finally, this book according to us is a timely read, as the world is coping with SARS-CoV-2 and thousands of families are coping with the loss of their loved ones, the book we hope will provide them with comfort by concreting the faith that no matter what the disease may be, it is the human will that will triumph in the end.

Self-Declaration

The book review is original and has not been previously published elsewhere.

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E-ISSN: 2581 - 8317

Application of In-Vitro Mutagenesis in Vegetable Sciences

Article ID: 12117

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Introduction

Mutagenesis can be defined as the process by which the genotype of an organism is altered in a stable manner. It is the process of generation of mutations. This can be utilized experimentally by means of different physical, biological and chemical agents. Therefore, mutagenesis can be natural or induced. The chemical or substance responsible for inducing mutation is referred to as mutagen. A mutant can be defined as an organism or a new genetic character, which is a result of mutation. This is generally a change of the DNA sequence of the genome or chromosome of an organism. The different types of experimental mutagenesis include induced mutagenesis, insertion mutagenesis and site-directed mutagenesis.

Vegetable breeding can be classified into 3 sub-types as mutation breeding, transgenic breeding and recombination breeding. In case of mutation breeding, the most relevant and the unique feature is the generation of new mutated alleles. Hugo de Vries in 1900 coined the term “mutation” to illustrate phenotypic changes that are heritable. Utilization of induced mutations for crop improvement is known as mutation breeding. In India, Swaminathan and his team at the Indian Agricultural Research Institute, New Delhi started a major programme of in-vitro mutagenesis in crop plants. The basic steps include analysis of difference in the sensitivity of different genotypes and plant tissues to different mutations often measured using lethal doses (LD).

Types of Mutagens

The three different types of common mutagens are observed in nature- physical, chemical mutagens along with biological agents. Different physical agents include heat and radiation. Besides chemical agents include the base analogs. Different biological agents like Viruses, Bacteria, Transposons are also reported to induce mutation.

Physical Mutagenic Agents

Radiation: Radiations are considered the primary mutagenic agent which were reported in 1920. UV rays, alpha rays, X-rays, neutrons and other ionizing and non-ionizing radiations are highly mutagenic. Usually, radiation directly damages the DNA or nucleotide structure, which could be either lethal or sub-lethal. The electromagnetic wave is additionally one in every of the known mutagens that cause harmful or sub-lethal mutations.

Heat: Heat is also considered to be an important mutagen altering our DNA. On heating the DNA, over a specific degree (>95°C), the DNA becomes denatured resulting in two single-stranded DNA generated from the dsDNA. Too high temperatures damage DNA and breaks the phosphodiester bonds too.

Chemical Mutagenic Agents

Base Analogs: The base analogs are chemicals including different bases of DNA- purines and pyrimidines which are structurally similar to the DNA bases. Bromouracil and aminopurine are two common base analogs incorporated into DNA- rather than usual bases, during the method of replication.

Alkylating Agents: Ethyl nitrosourea, poison gas and vinyl chloride are common alkylating agents that are responsible for adding alkyl groups to the DNA and damages it. The agents induce base-pairing errors by increasing ionization and produce gaps within the DNA strand. The alkylated purine bases are removed by the phenomenon referred to as depurination. Common alkylating agents include Methylhydrazine, Busulfan, Thio-TEPA, Temozolomide, Dacarbazine, Ethyl ethane sulfate, Carmustine, Dimethyl sulfate *etc*.

Intercalating Agents: The EtBr- ethidium bromide applied during the agarose gel electrophoresis is a highly relevant intercalating agent. Other intercalating agents include proflavine, daunorubicin, acridine orange or operated by an identical mechanism like the EtBr. The molecules intercalate between the bases of DNA and disrupt its structure.

Metal Ions: Metal ions are also considered to be highly dangerous to our DNA. Nickel, chromium, cobalt, chromium, cadmium, arsenic and iron are a number of the standard metal ions that are responsible for causing mutations. The metal ions effect by production of ROS (reactive oxygen species) thereby hindering the DNA repair pathway causing DNA hypermethylation or may directly by destruction of the DNA.

Other Chemical Mutagens: ROS, gum elastic, benzene and rubber products, aromatic amines, sodium azide, alkaloids, deaminating agents and PAH (Polycyclic aromatic hydrocarbons) are other mutagens that make different mutations.

Biological Mutagenic Agents:

Virus: Viruses cause mutations by inserting their DNA into genome thereby disrupting the traditional function of DNA or genes. Once it inserts DNA, the DNA replication followed ny transcription and translation of viral protein takes place.

Bacteria: Some bacteria also are dangerous for DNA- resulting in inflammation. It provokes DNA damage and DNA breakage.

Transposons: They are also referred to as biological mutagens. The transposons are non-coding DNA sequences that jump and change their locus from one place to a different place in an exceedingly large genome, and influence the function of genes.

Mutagenesis Methods

Chemical mutagenesis has been considered to be one of the most efficient and convenient approaches applied in diverse plant species. The EMS is the highly used chemical mutagen in plants because of its high efficiency at inducing point mutations and deletions in the chromosomal segments. Conventional mutation techniques have helped in both forward as well as reverse genetic studies. One of the reverse genetics tools, targeted induced local lesions in genomes (TILLING) has been developed to identify allelic variation of mutants efficiently. The TILLING approach have been used for screening of mutant population developed by EMS and fast neutron mutant for enhancement of the genomics studies. EcoTILLING, which is a referred to as variant of TILLING, examines natural genetic variation in populations. It is also considered for detection of SNPs.

Zinc finger nucleases (ZFNs)-based genome editing has been considered as one of the primitive technologies which makes it possible to perform precise site-specific mutations. The ZFNs have been reported to form dimmers recognizing a specific target site and make a double-strand DNA break. At the target site, the repair mechanism leads to variations like insertions, deletions and single nucleotide polymorphisms (SNPs). The ZFN approach have been used in several plant species.

Transcription activator-like effector nucleases (TALENs) have been composed of a free designable DNA which have been successfully employed for specific gene mutation in many plant species. The first successful report on gene editing in tomato by TALENs was reported in 2014.

Until 2013, ZFNs and TALENs were considered for the precise genome-editing. Both of these methods have become least preferred choice after the development of more efficient and easier method like CRISPR/Cas9-based genome editing. The CRISPR/Cas9 strategy has been considered a ground-breaking genome editing tool.

Applications of In-Vitro mutagenesis in Different Vegetable Crops

Plant	Trait	Candidate gene(s)	Method(s) of mutation
Tomato	Fruit quality	PG	TILLING
	Virus resistance	eIF4E	Sequencing
Melon	Virus resistance	eIF4E	EcoTILLING
	Fruit quality	ACO1	TILLING
Potato	Starch quality	Waxy	Sequencing
Pea	Height	LE	TILLING
	Multiple traits	20 genes	TILLING
Bean	Virus resistance	bgm-1	EcoTILLING

Cabbage	Multiple traits	15 genes	TILLING

Minoia *et al.,* 2010 designed and applied a new mutant genetic resource for tomato crop improvement by TILLING technology. The general applicability of TILLING makes it highly efficient for genetic modification of vegetable crops. Kangarasu *et al*., 2014 used different doses of gamma rays *i.e*. 15, 20 and 25 kR for induction of flower colour and seed mutants in M2 generation mutation in dormant seeds of *Phaseolus vulgaris* L. cv. Waghya.

Induced mutants of cauliflower can also be screened for drought and salt tolerance through N-nitroso-N-ethyl urea (NEU) and N-nitroso-N- methyl urea (NMU) (Hadi and Fuller, 2013). Shalaby and Banna (2013) reported an invitro technique suitable for mutation induction on tomato and characterize them by use of different RAPD and SSR markers as well as horticultural characteristics. Elangovan and Pavadai (2015) conducted an experiment to determine the effect of different concentration of ethyl methane sulphonate (EMS) and diethyl sulphate (DES).

Singh *et al*. (2011) experimented on seeds of three genotypes of okra *viz.,* Parbhani Kranti, Hisar Unnat and Satdhari treated with gamma rays (15, 30, 45 and 60 kR) and EMS (0.25, 0.50, 0.75 and 1.00%).

Future Prospects of In-Vitro Mutagenesis in Vegetable Sciences

Globally, food security has faced a major deterioration in the past few years; food costs are mounting massively and poor people are under the threats of serious malnutrition. Induced mutations have the capability to enhance the rate of domestication of many vegetable crops that may be significantly useful as a source of food, forage and industrial raw materials. It is striking that a huge number of mutant varieties have been developed and widely cultivated in developing countries, hence greatly improving their food security. In recent era, induced mutations, as a tool, is gaining momentum in the field of plant molecular biology for identification, isolation and study of the structure and function of such genes which are actually of imperative use in breeding studies.

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E-ISSN: 2581 - 8317

Transporters: Role and Functions in Plants

Article ID: 12118

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Introduction

The structure of plant roots, stems, and leaves facilitate the transport of water, nutrients, and photosynthates throughout the plant. The phloem and xylem are the main tissues responsible for this movement. Water potential, evapotranspiration, and stomatal regulation influence how water and nutrients are transported in plants. Given the constant increase in world population, high-yield crop production has become a necessity for agriculture. As that the nutrient sources of the land are limited, the input of nutrients by the addition of fertilizers ensures a continuous supply for plants, circumventing reductions in plant yield. The use of fertilizers has raised crop yield considerably, but the problem is the cell membrane, it acts as a barrier for transporting. The cell membrane is a thin semi-permeable membrane that surrounds the cytoplasm of a cell. Its function is to protect the integrity of the interior of the cell by allowing certain substances into the cell while keeping other substances out. The plasma membrane contains over 100 different proteins, enzymes, transport proteins, structural proteins, antigens, and receptors for various molecules. More number transporters are present in the membrane region for efficient transport and it is specific to the location and molecules. Minerals are major determinants of plant growth and fertility in nature and agriculture. Plants can take up these minerals only as soluble forms, such as ions in soil solutions. Nutrient solubility depends on the chemical form of each nutrient, which is affected by environmental factors, including water content, pH, redox potential, an abundance of organic matter, and microorganisms in soils (Marschner H, 2011). One useful strategy for efficient nutrient uptake is the modulation of transport activity within and among plant organs.

Membrane Transport System

The membrane transport system is the transport system by which various molecules enter into and out of the cell across the cell membrane. Cells have various transport mechanisms. Based on whether the molecules pass directly through lipid bilayer or via membrane channel, whether or not the molecules are altered as it passes through the membrane, whether or not the process requires energy, the membrane transport system is categorized into two major groups (Fig.1).

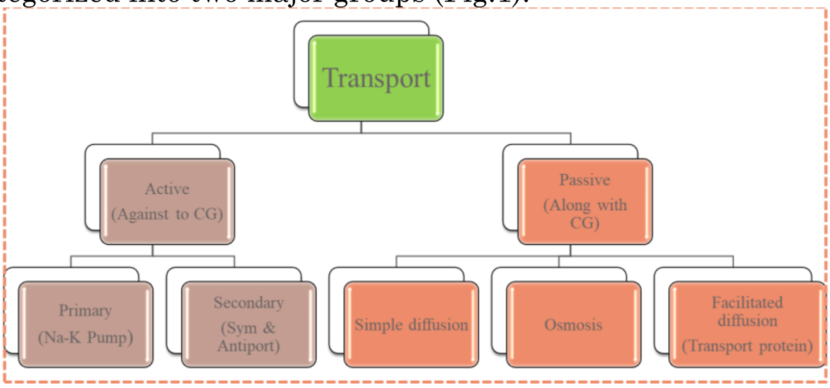

Fig.1. Transport classification

Active Transport

Active transport requires transporter protein and a continuous supply of cellular energy for the transport of molecules across the concentration gradient (CG) of the membrane (Fig.2). Active transport is very important to transport the molecules which are present in very low concentrations in the medium. Inactive transport permease or transporter protein carries the molecules across the membrane and the energy required to transport is obtained by ATP or Ion gradient. The substances transported by active transport are glucose, amino acids, organic acids, and inorganic ions ($SO4^-$, $PO4^-$, K^+, etc.,).

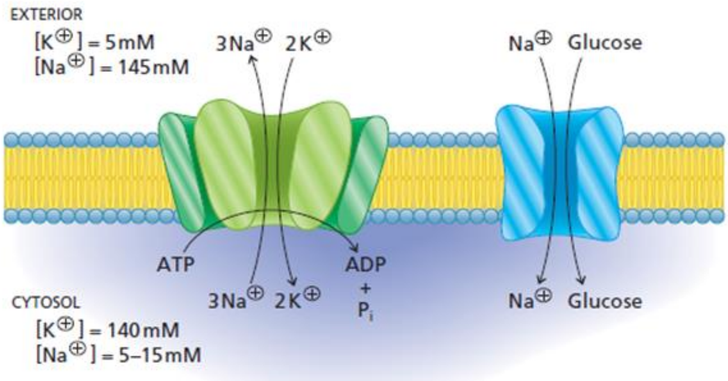

Fig.2. Active transport

1. Primary active transport: In primary active transport, hydrolysis of energy-rich molecules such as ATP provides the energy required for the transport of molecules from lower concentrations to higher concentrations across the membrane.

2. Secondary active transport: In secondary active transport, one type of molecule migrates from higher concentration to lower concentration, releasing energy. This released energy is used to transport another molecule from its lower concentration to a higher concentration across the cell membrane.

Passive Transport

The passive transport mechanism does not require cellular energy to transport molecules across the cell membrane. So, it is a passive process (Fig. 3). In this transport system, molecules are transported from their higher concentration to the lower concentration until the concentration gradient is diminished. Passive transport does not work against the concentration gradient.

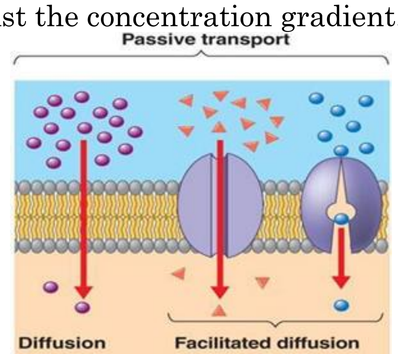

Fig.3. Passive transport

1. Simple diffusion: Simple diffusion is the transport or movement of molecules from higher concentration to lower concentration without the expenditure of energy. In this process, molecules simply diffuse through the pore of the cell membrane. Simple diffusion does not require transporter protein. When the concentration of molecules is different inside and outside of the cell membrane, a concentration gradient is established. Then the molecules move from higher concentration to lower concentration until equilibrium is maintained. When the concentration of molecules becomes equal on both sides of the membrane, the transport process stops. In some case, the molecules after entering the cell transform metabolically, preventing to build up a concentration of transported molecules, hence the concentration gradient remain established. The rate of diffusion is determined by the concentration gradient and permeability of the cytoplasmic membrane. The greater the concentration gradient and permeability of the cell membrane, the greater will be the rate of passive diffusion.

2. Osmosis: The movement of solvent (water) across the membrane in response to the concentration gradient of solute is known as Osmosis. Bacterial cytoplasm has generally higher solute concentration than its surrounding. There are 3 types of solution based on comparison to the bacterial cytoplasmic concentration. In an isotonic solution, water moves equally in both directions inside and outside of the cell. In a hypertonic solution, water moves out of the cell so that cell shrinks. The process is known as plasmolysis. In a hypotonic solution, water moves inside the cell so that cell swells up. The process is known as plasmolysis.

3. Facilitated diffusion: The process of facilitated diffusion is similar to simple diffusion as the molecules flow from higher concentration to lower concentration but it is different from simple diffusion because it requires transporter protein for the process. The transporter protein is known as Permease or Porter or carrier protein. The transporter protein is specific however some can transport multiple compounds. At first solute molecule binds with the transporter protein and changes the 3D structure of the transporter protein and this change in shape allows the solute to be carried across the membrane.

Transport Proteins

A transport protein is a protein that serves the function of moving other materials like ions, small molecules, or macromolecules, such as another protein, across a biological membrane within an organism.

May be:
1. Channels- Ion channel.
2. Carriers- Secondary active transport.
3. Pumps- Primary active transport.

Ion Channel

They are either voltage-gated or ligand-gated. Some channels open and close in response to mechanical signals as well. Ion channels are a type of transmembrane proteins with multimeric subunits. Upon opening, specific ions can flow through the ion channel through either a concentration or electrochemical gradient.

Transporters

Transporter refers to a transmembrane protein that transports ions across the cell membrane against the concentration gradient by active transport.

Diverse Functions of Transporters

To acquire and distribute essential nutrients efficiently under nutrient starvation, nutrient transport must be coordinated by transport molecules in plant organs. Table. 1 shows the major transport processes within an individual plant include:
1. Uptake from the soil to root cells
2. Xylem loading
3. Distribution/remobilization into sink organs in shoots.

Table 1. Transporters are involved in transport of specific element:

Transporter	Ion	Expression	Crop	References
NRT2.4, NRT2.5 and NRT2.1	Nitrogen	N uptake in root	A. thaliana	Lezhneva et al., (2014)
MGT6	Mg	Root plasma membrane	A. thaliana	Mao et al., (2014)
MRS/MGT	Mg	Chloroplast	Oryza sativa	Saito et al., (2013)
HAK5 and AKT1	K		A. thaliana	Caballero et al., (2012)
OsNramp5	Mn		Oryza sativa	Sasaki et al., (2012)
OsHMA5	Cu/Cd	Root pericycle	Oryza sativa	Deng et al., (2013)
OsHMA2	Zn	Root to shoot translocation	Oryza sativa	Satoh-Nagasawa et al., (2012)

Conclusion

Transporters carry diverse molecules important for the survival of plants. Fundamental research into transport mechanisms in plants is leading to rapid innovations for improving yields, extending the range of land that can be used for crops, and improving the performance of plants under stress.

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Hybrid Rice Seed Production

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Summary
Rice is staple food of more than 60 % of Indian population. It accounts for about 43 % of total food grain production and 46 % of total cereal production in the country. In order to meet the domestic demand of the increasing population the present-day production of 99 million tons (2008) of milled rice has to be increased to 125 million tons by the year 2030. Since the yield of high yielding varieties (HYVs) of rice is plateauing, it is rather difficult to achieve this target with the present-day inbred varieties. Therefore, to sustain the self-sufficiency in rice, additional production of 1.5 million tons is needed every year. Among the limited options, hybrid technology is the only proven technology currently available for stepping up rice production significantly. The rice hybrids, recently introduced in cultivation, on an average, give 10 to 15 q/ha additional yield over the conventional varieties (about 20 % increase). Therefore, the introduction of hybrids and popularization of their production technology are feasible and readily adoptable to achieve targeted production.

Introduction
What is hybrid rice?
Like in other crops, the first-generation progeny (F_1) obtained by crossing two genetically different varieties (parents) of rice is called 'Hybrid'. Since rice is self-pollinated, cytoplasmic male sterile (CMS) parent is used as female parent, which is normally called 'A' line. The fertility restoring line which is called 'pollinator' to the female parent is known as male parent. It is generally referred to as 'R' line, and is used for hybrid seed production. The hybrid combines the desirable characters from CMS line and R line. They exhibit vigour for several quantitative characters including yield. They exhibit buffering capacity to counteract several biotic and abiotic factors that limit productivity. While developing/evaluating hybrids, the combinations of varieties that exhibit vigour or heterotic effect for yield are selected. The hybrid seed is purchased or procured afresh every year/ season for raising the commercial crop. The harvested grains from hybrid crop should not be used for planting the next crop (Xia *et. al.*, 2019).

Chinese Experience of Hybrid Rice
The Chinese scientists were the first in the world to develop commercial hybrids in rice and the first hybrid was released in 1976. Now, China covers 53% of its rice area and about 58% of production under hybrid rice.

Hybrid Rice in India
Taking cue from the success of hybrid rice technology in China, systematic research efforts on hybrid rice in India were initiated in 1989, when Indian Council of Agricultural Research (ICAR) launched a special goal oriented and time bound project on 'Promotion of Research and Development Efforts on Hybrids in Selected Crops' (Zhu Q., 2004). For rice, National Network Project involving 12 centers was initiated.

Hybrid Seed Production
The success of hybrid rice technology primarily depends on genetic purity, timely availability and the affordability of hybrid seed costs to the farmers. The production of pure hybrid seed at affordable price in rice- a self-pollinated crop, is a highly skill-oriented activity. A good hybrid may not reach a large number of farmers, unless it is feasible to commercially produce the seed on large scale economically. Though there are two systems **(2-line and 3- line)** hybrid breeding and seed production, but at presently three-line method, using cytoplasmic male sterility system, is in vogue. In this system, three lines (parents) are involved in hybrid seed production (Guo-hui and Long-ping, 2015). These parents are:

1. A line: It is cytoplasmic male sterile line which is used as female parent in hybrid seed production. It is maintained by crossing with the B line (maintainer line). Both these lines are iso-genic having homozygous recessive nuclear genes conferring male sterility, differing only in cytoplasm which is sterile (S) in A line and fertile (N) in its maintainer, the B line (Zhu, Z., 2010).

2. B line: It is iso-genic to A line and is used as pollen parent to maintain male sterility in A line. This line is maintained by growing in isolation, atleast 5 m away from any rice variety.

3. R line: This is also called as fertility restorer or pollinator line. This is used in hybrid seed production by growing along-with A line in a standard row ratio. It is also maintained by growing in isolation, at least 5 m away from any rice variety.

Climatic and Resource Requirement

At present Karim Nagar, Warangal, Kurnool and Nandyal districts in Andhra Pradesh, Tumkur, Mandya and Mysore districts in Karnataka, Kohlapur district in Maharashtra and Erode and Bhawanisagar districts in Tamil Nadu are being used for seed production of hybrid rice.

1. Seeding time and season: The transplanting of seedlings of parental lines should be planned in such a way that flowering doesn’t coincide with rains.

2. Temperature requirement: The daily mean temperature of 24-300 C, relative humidity of 72-80 %, difference in day and night temperature in the range of 8-100 C.

3. Soil conditions: The field should be fertile with uniform topography, having good drainage and irrigation facilities and free from ‘volunteer plants.

Nursery Raising and Seed Rate

To ensure multi-tillered (4-5 tillers) seedlings and convenience in uprooting, sparse seeding in nursery is desirable. For this, 30 g seeds/m2 would be required.

Isolation

For ensuring genetic purity of the parental and hybrid seeds, optimum isolation is required.

Row Ratio and Planting Pattern

Following features of rice plant have profound effect on row ratio.
1. Taller the pollinator, larger number of female rows it may cover or pollinate.
2. Vigorous pollinator may pollinate larger number of female rows.

Spacing and Method of Transplanting

The spacing between various parents should be as follows. Male: Male = 30 cm, Male: Female = 20 cm, Female: Female = 15 cm, Plant: Plant =15 cm or 10 cm.

Application of Gibberellic Acid (GA3)

It is an efficient and effective growth hormone, which stimulates the cell elongation and thus advances the panicle exsertion in female line.

Synchronization

Synchronization of flowering of male and female parents ensures higher hybrid seed yield.

Roguing

To ensure high genetic and physical purity of hybrid seed, it is essential to follow roguing in the following stages: -**At vegetative phase**, **flowering and at maturity.**

Weed Management

2.5-3.0 kg of Butachlor should be mixed in 50-70 kg of sand and apply in one ha area after 5-6 days of transplanting.

Nutrient Management

25% of the recommended dose of N in the form of urea should be applied at 30-35 days of planting and remaining 25% nitrogen and 25% of potash should be applied at 70-75 days after transplanting or at panicle initiation stage.

Water Management

A thin film of water should be maintained for initial 30 days. The water level is increased later on to 4-5 cm when the crop reaches maximum tillering stage.

Harvesting, Threshing and Processing

First, the male parent (pollen parent or R line) should be harvested, followed by the female parent. Also, the threshing should be done separately. After drying, the seed should be bagged with labels both inside and outside the bags. The seed yields used to be very low (3 to 5 q/ha), but with experience over the years, 15 to 25 q/ha average yields are being obtained now (Khanday *et al*., 2019). Hence, large-scale seed production is generally taken in dry season only. Hybrid seed production in the country, starting from less than 2000 q in the year 1995 has crossed 3, 00,000 q from 20,000 ha.

Problems in Hybrid Seed Production

1. Constraints of suitable area:
2. Poor performance of seed production of public bred rice hybrids:
3. High seed cost:
4. Less time gap between harvest of seed and its use for sowing:

First Basmati Rice Hybrid **Popular Basmati Rice Variety**

Conclusion

The breeding and large-scale adoption of hybrid rice is an important achievement in modern agriculture. Mechanized seed production is urgently needed for widespread adoption of hybrid rice because it can compensate for the shortage of manual labor to meet the growing food demands in world.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Impact on Agri- Horticulture Marketing Due to Covid – 19 Crisis

Article ID: 12120

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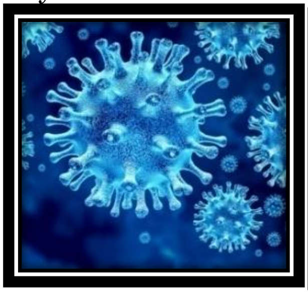
Introduction

There is a saying that **"Annadhata sukhibhava"** it means let the one who provided me food be happy but now in India farmers constantly battle against skewed monsoon and erratic rainfall, extreme natural events and interrupted supply chains. Like this was not enough. These troubles now are supplemented this year by the COVID induced lockdowns, the locusts attack, marketing problems and APMC act!




The agricultural sector in the India accounts for 60% of all rural employment and is thus the single largest source of livelihoods. In agricultural marketing transportation cost, inadequate market infrastructure, lack of market information, lack of processing units, storage facility, price fluctuation are the major problems. Among all these problems, marketing and transportation charges are concerned as a major problem by the maximum number of farmers. In India, there are four systems of agricultural marketing like sale in village, sale in mandi, sale in market and cooperative marketing. Eliminating middlemen, enough storage facility, freedom from moneylenders, adequate transportation facilities, availability of loan and training facilities *etc.* are required for satisfactory agricultural marketing.

What is Marketing?

Marketing covers the services involved in moving an agricultural product from the farm to the consumer. These services involve the planning, organizing, directing and handling of agricultural produce in such a way as to satisfy farmers, intermediaries and consumers. Number of interconnected activities are involved in doing this, such as planning production, growing and harvesting, grading, packing and packaging, transport, storage, agro- and food processing, provision of market information, distribution, advertising and sale.

How COVID Impact on Agri- Horticulture?

1. The first main visible impact of COVID-19 in the rural sector is on the agricultural goods supply chain. While the government has provided permits to trucks allowing them to carry groceries, fruits, vegetables, flowers and cereals, a large number of transporters are still to receive their permits.

2. Delay in sowing and harvesting of the crops due to the non-availability of products such as planting materials, seeds, tractors, ancillary support, medicines for crop protection.

3. The third impact of COVID-19 is the expected job cuts in the agricultural sector.

4. The big impact is complete shutdown of exports. India is the major exporter of crops and as per APEDA (Agricultural and processed food products export development authority), India's overall agri-exports in 2018-19 were to the tune of Rs. 685 billion.

5. And also, on small industry units, businesses/traders, and shops that manages a decent size inventory and employ numerous direct and indirect employees.

Problems in Agri- Horticulture Marketing in India

"One Nation One Market" Policy

According to Ashok Dalawai committee report on doubling the farmer's income, the share of farmers in consumers price is very low. And if same follows on, India would have compromise with its target of doubling farmer's income by 2022. So, to avoid such issues in APMC (Agricultural produce market committee) and mandies controlled by state. The government has come up with the National Agriculture Market (e-NAM) *i.e.,* one nation and one market model. Benefit from this model is there is no role of middlemen.

Farm Bills 2020

Farmers' produce trade and commerce (Promotion and Facilitation) bill: The government now sought to project the farm bill as "creating an ecosystem" where farmers can enjoy the "freedom of choice" to sell to anyone, anywhere in our country. This law states that the current system of minimum support price (MSP)-based procurement of foodgrains by government agencies will end. The APMCs can't stop functioning either; nothing prevents farmers from selling their produce or traders and processors from buying in these mandis.

One of the important key challenges in the Indian farming sector is the inability of the farmer to get a reasonable price for his produce. For long, the central and the state governments have a mechanism of minimum support price (MSP) or a floor procurement price for agricultural commodities to provide income security to the farmers.

What is e-NAM?

Effective implementation of higher support prices via MSP has remained a challenge over the years with APMCs not able to ensure a good price to the farmers through the mandi (local market) auctions. In our opinion, this can be alleviated by taking advantage of the e-NAM, one of the digital initiatives by the government that can bring about significant efficiencies in the system and act as an effective tool to fight inflation or price distortions and also reduce the procurement burden on the exchequer simultaneously. e-NAM will allow prices to be governed by market forces by keeping the middlemen at bay allowing buyers and sellers a fair price. The mechanism when fully operational, will allow free movement of food commodities across the country while mitigating the problems.

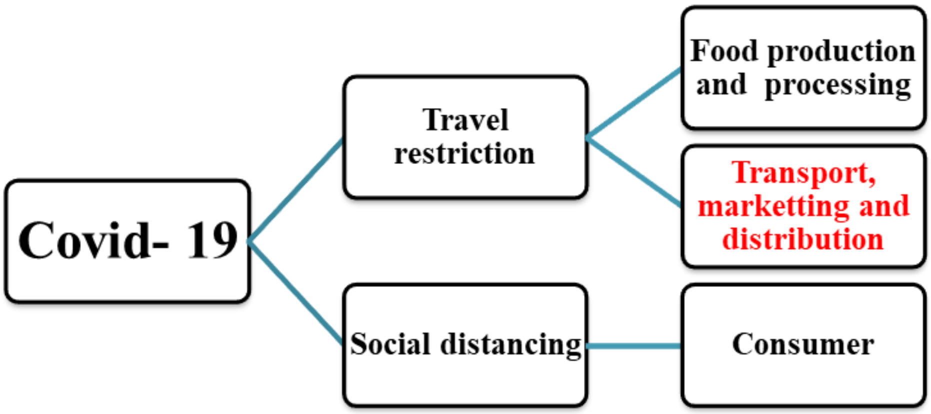


Figure 1: The figure shows COVID-19 affecting every stage of food supply chain with major impact on food transport and marketing

Suggestions to Overcome Agricultural Marketing Problems in India

1. Elimination of mediators (middlemen)
2. Use of standard weight
3. Loan facilities
4. Development of means of transport
5. Publicity of market policies
6. Training facilities
7. Regulation of 'mandis'
8. Market survey
9. Stores management
10. Grading and standardization of products.

Conclusion

The pandemic led crisis has wreaked havoc on both the Indian and global agricultural system. A global food security crisis is in potentially looming that cannot be countered without understanding the impacts of COVID-19 on the agricultural system, especially of the developing countries.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Scope and Prospectus of Terrace Farming in 21th Century

Article ID: 12121

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Introduction

In today's metropolitan setting, substantial urban acreage has been acquired by high-rise structures, parking lots, and road networks. In such a crowded setting, building rooftops and terraces represent a vital potential supply of outdoor space for building users. The twenty-first century has been dubbed the "New Era of Roof Gardens." This document provides an overview of current advancements in roof gardening technique throughout the world- In the twentieth century, Germany was the birthplace of large roof gardens. This has been the case in Germany since the 1960s. In various sections of Berlin, 5-30 percent of roof space has been greened. In 2008, around 100,000 m2 of green roofs were built in London and Shanghai. Approximately 1 million m2 of roofs are greened each year in France and North America. Every year, Germany installs around 11 million m2 of green roofs.

Definition of Terrace Farming

Terrace farming is defined as farming that takes place on a terrace, roof, or patio, generally in a home with limited gardening area. In metropolitan settings, this form of terrace farming is very popular. Terrace farming is most often done on one of three levels: 1. On a building's rooftop. 2. Projected levels out of the tower block, above the ground level, such as porches, window boxes, porticos, balconies, and other similar structures 3. On the podium, at the base, or on the roofs of big basements. It's also known as a roof garden, a rooftop garden, or a terrace garden (Patel et al. 2019).

Terrace Farming May be Divided into Three Categories

1. Rooftop container farming: This entails growing vegetables, herbs, and flowers in a variety of containers such as Benches, Troughs, Pots and Containers, Earthen pots, Plastic pots, Fiber pots, Seed pans and seed boxes, Polythene bags, Paraffin paper, or Styrofoam cups, which can be filled with a fine mixture of soil, sand, and compost (2:1:1) loosely with a gentle tap, with one with one inch head space at the top for irrigation.

2. Rooftop hydroponic systems: Also referred to as "plant cultivation without soil." The roots absorb a balanced nutrition solution that satisfies all of the plant's developmental needs. Different media, such as sand, rice hull and shell, clay bricks, coconut fiber, charcoal, saw dust, water, and volcanic stones, are used to aid plant development.

There are two types of hydroponic systems:

- **i. Open System-**Instead of being re-cycled, the nutrient solution in an open hydroponics system is mixed and supplied to the plant as needed.
- **ii. Closed system:** In this system, the nutrient solution is continually cycled, giving the plant with the nutrients it requires.

3. Direct producing green roofs: Green roofs are structures with a growth substrate and plants covering the roofs. Roof gardens, living roofs, and eco-roofs are all terms for the same thing. (Jafari *et al.,* 2015).

Types of Direct Producing Green Roofs System

1. Extensive Green Roof: These are ideal for roofs with a medium load bearing capability. The costs of constructing a large roof garden are cheaper. These types of green roofs have a low nutritional content. It is not particularly deep, but it is appropriate for plant communities that are less demanding and grow slowly.

2. Intensive Green Roof: Everything that can be planted in a ground garden, such as lawn, perennials, shrubs, and trees, may be planted on Intensive Green Roofs. Additional amenities on the roof might include walkways, seats, playgrounds, and even ponds. In terms of design and originality, there are no bounds. Intensive green roofs, on the other hand, are far more expensive than large green roofs.

3. Semi-Intensive Green Roof: A hybrid of the extensive and intensive green roofs. Maintenance is performed on a regular basis at a cost that is in the centre of both categories, with higher weight but less intensity. A deeper substrate level opens us additional design choices. Grass, herbaceous perennials, and shrubs are all present, but towering bushes and trees are still absent.

Green Roof System Components

1. Roof Deck and Water proofing membrane: The decking of a green roof, which can be made of concrete, wood, metal, plastic, gypsum, or composite, is the most essential layer since it determines whether the structure can support the green roof's weight. The increased dead and live load (because to the growing media) necessitates additional structural support and water retention when installing a green roof. Buildings with concrete decks are good candidates for green roofs because they can sustain the increased weight of the green roofs and do not require the additional support that a metal deck would require. The basic goal of a waterproofing membrane is to keep rain and condensation moisture away from the building underneath. It is the slab's principal protective feature and is generally found beneath all of the components of a green roof system.

2. Insulation and Protection Layer and root barrier: The roof is the major place for heat transmission, and insulation prevents heat energy from being transferred through the roof by forming a barrier between spaces of various temperatures. The insulation works as a thermal barrier, preventing condensation on surfaces that are heated and cooled on opposing sides. The insulating characteristics of the growth media are determined by its depth and moisture content. Because green roofs contain living and growing materials, one of the most essential components of the assembly is a protective layer and a root barrier. The root barrier, which is positioned above the membrane, prevents roots from passing through and damaging the membrane. After the waterproofing membrane has been placed, a protective layer protects it from harm.

3. Drainage and retention Layer: A drainage channel allows moisture to flow horizontally through the green roof system. It avoids oversaturation, ensures root ventilation, and gives the roots more room to expand. It's a porous, continuous layer that runs the length of the roof, right above the concrete slab. A moisture retention layer holds or stores moisture for plant development, which is necessary for effective plant multiplication. It's an absorbent mat that's usually placed above the drainage layer or the aeration layer.

4. Root Permeable filter Layer: The filter layer keeps the growth media from moving and washing away by separating it from the drainage layer. This layer prevents clogging by restricting the passage of tiny soil particles and other impurities while allowing water to easily pass through. They are generally in the shape of filter cloth or mats and are constructed of densely woven fabric.

5. Growth media: When selecting growth media, several factors should be considered, including:

a. Low dry and bulk density: Wet bulk density is also an essential characteristic, since some substraate constituents quickly get saturated during rain events, increasing total weight.

b. Low organic content: Peat, mulch, and various composts are some of the most frequent organic elements utilised in green roof substrate. 100% composts should not be used on the roof since they may cause the vegetative support course to shrink, stimulate the development of unwanted weeds, and raise the rooftop load during rain events.

c. High WHC: The water holding capacity (WHC) of substrate components is important for plant survival in drought. Water holding capacity is increased by increasing substrate volume, depth, and organic content (WHC).

d. High stability: The growth substrate should be stable as well, with low-density inorganic recycled materials being the most stable.

e. Plant anchoring: Growth substrate should be stable, support a wide range of species, and give strong plant anchorage.

f. Vegetation layer terrace farming: Plants are typically chosen based on weight, long-lasting plant coverage, ease of maintenance, and tolerance to harsh environmental conditions such as thin growing media, high sun exposure, limited water sources, increased wind speeds, and extended dry periods. Plants with thin, sharp stems should be avoided. Root vegetables are also a good choice because of their slow development. A thick root also aids in the anchoring of the plants into the ground and provides wind resistance.

Vegetable Crops Suited for Terrace Gardening

1. Transplanted vegetables: Tomato, Brinjal, Chilli.
2. Direct sown vegetables: Okra, Amaranthus, Cucurbits Bitter gourd, Radish and Beet root.
3. Perennial Vegetables: Curly leaf, culinary banana.
4. Spice crops suited for roof garden: Turmeric, Coriander and Fenugreek.
5. Fruits crops: Banana, Papaya (needs proper staking).
6. Medicinal Plants: *Aloe vera, mexican mint, Ocimum sanctus.*
7. Flower crops: Rose, Jasmine, Chrysanthemum, Tube rose, Marigold
8. ***Sedum spp*.,** a succulent ground cover, has become very famous to be used in green roofs.
9. Cereal crop: rice, wheat, millets, sweet corn.
10. Pulses: Kidneybean, mungbean, gram, blackgram.

The Importance of Roof Garden

1. Private benefits:

a. Increased roof life: The roof garden helps to extend the building's anticipated roof life. The roof of a concrete flat has a lifespan of just 15 to 25 years. UV rays and high Ozone ratios speed up the ageing process, causing material fatigue, shrinkage, crack development, and leaking. Green Roofs provide a layer of protection from the sun as well as mechanical harm such as hail, wind, and pyrotechnics.

b. Heat Shield: During the summer, the roof garden helps to cool the inside by allowing air to circulate. Vegetated roofs help prevent the normal warming of urban apartments in the summer. Due to the existence of a plant layer, the thermal loads caused by solar radiation and air temperature are restricted. In addition, the growing media adds insulation to the roof, and the water content improves the structure's thermal inertia. During both summer and winter, the plant layer acts as a temperature buffer.

c. Enhance social connections, the work environment, and the overall quality of life: a reprieve from a monotonous lifestyle. The roof garden encourages people to interact with one another. It encourages social interaction and the sharing of ideas, therefore improving one's quality of life. It also vastly improves the working atmosphere. Roof gardens appear as a source of respite from our boring urban existence. It allows us to recover from weariness caused by the concreteness of cities. Rooftop gardening can help urban dwellers become more self-sufficient.

d. Food production: In high-density urban areas where garden space is limited, roof spaces provide a chance to cultivate specific sorts of food. Food production on rooftops would: I allow residents to have complete control over the growth regime, including growing media, fertilisers, and pest management. ii) Provide fresh food to the residents. iii) give educational value by teaching people how to cultivate their own food.

2. Public benefit:

a. Urban heat island effect: The "urban heat island effect" refers to the temperature differential between a city and the surrounding countryside. Excess heat from residential structures, industry, and transportation is contributing to rising temperatures in metropolitan areas as a result of global warming. This impact can reach approximately 10 °C in the summer. The urban heat island effect has a significant negative impact on the quality of life and the health of the city's residents. Natural air conditioners like parks and green spaces may absorb up to 80% of the heat.

b. Reduction of dust and smog levels: Pollutants in the inner-city air, such as NO2, NO3, CO, volatile organic compounds, and diesel exhaust gases, create hazardous combinations for city dwellers. Roof gardens can help to alleviate this problem. A green roof of 1 m2 can filter around 0.2 kilogramme of aerosol dust and smog particles each year.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Conservation Agriculture – New Paradigm Farming

Article ID: 12122

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Introduction

In the mid-1960s, India saw significant agricultural expansion, notably during the green period, which saw the introduction of fertilizer-responsive high-yielding rice and wheat cultivars. Since 1965, the yield of main crops has grown three to fourfold, allowing the country to become self-sufficient in food grain production. For the past few years, the standstill in food grain output and productivity has been a source of significant concern. The key difficulties include ensuring food security for a growing population and decreasing poverty while maintaining agricultural systems in the current environment of dwindling natural resources, unfavourable climatic impacts, rising input costs, and unpredictable food prices. In addition to these issues, the main indications of agricultural system non-sustainability are soil erosion and soil organic matter loss. These are mostly caused by (1) soil organic matter loss, soil structural deterioration, water and wind erosion, lower water penetration rates, surface sealing and crusting, and soil compaction caused by heavy ploughing (2) inadequate organic material return and (3) mono cropping. As a result, for future productivity improvements while preserving natural resources, an optimum change in agricultural techniques involving the elimination of unsustainable components of traditional agriculture is critical.

What is Conservation Agriculture, and how does it Work?

Conservation agriculture (CA) is an agricultural technique that helps to preserve arable land while also restoring damaged areas. It encourages the preservation of a permanent soil cover, little soil disturbance, and plant diversity. It improves biodiversity and natural biological processes above and below ground, resulting in more efficient water and fertiliser usage, as well as better and long-term crop production.

Difference Between Conventional Agriculture and Conservation Agriculture

Conventional agriculture	Conservation agriculture
Using science and technology to conquer nature by cultivating land	Natural processes are not harmed as much as possible.
Soil erosion and excessive mechanical tillage	No-till or minimal tillage (biological tillage)
Windy conditions and soil erosion	Low wind and erosion of the soil
Burning or removal of residue (bare surface)	Retention of residues on the surface (permanently covered)
Water infiltration is low	Infiltration of water is minimal.
Ex-situ FYM/composts are used.	In-situ organics/composts are used.
Green manure is a type of fertiliser that is used (incorporated)	Cover crops/brown manuring (surface retention)
Kills existing weeds while also encouraging additional weed seeds to sprout.	Weeds are a nuisance in the early phases of adoption, but they eventually go away.
Increased soil compaction due to free-wheeling agricultural machinery	Controlled traffic, tramline compaction, and no compaction in the crop area
Less efficient rotations, monocropping/culture	Rotations that are more diverse and efficient
The reliance on physical labour is high, and operations are unpredictable.	Mechanized operations guarantee that operations are completed on schedule.
Poor stress adaption leads to higher yield losses under stressful situations. .	Stress resistance is improved, and yield losses are reduced in stressful situations.
Long-term productivity increases are on the decline.	Long-term productivity increases are made in steps.

Conservation Agriculture's Current State in India and Overseas

Conservation agriculture is implemented on around 125 million hectares worldwide. The United States was the first country to implement conservation agricultural techniques, with more than 25.5 million hectares of land now under such management. Brazil (25.5 million hectares), Argentina (25.5 million hectares), Canada (13.5 million hectares), and Australia are among the countries where conservation agricultural methods have been widely embraced for many years (17.0 M ha). Conservation agriculture was being practised in roughly one million hectares of land under annual crops in France and Spain. In India, the total area under no-tillage/zero-tillage is around 3.43 million hectares. For almost a decade, efforts have been made to adapt and promote resource conservation technology. Conservation agriculture has spread across the country thanks to the combined efforts of numerous SAUs and ICAR institutions. In the irrigated parts of the Indo-Gangetic plains, where rice-wheat cultivation prevails, conservation agriculture practises are being used. Other important agro-ecoregions, such as the rainfed semi-arid tropics and the arid areas, have not attempted or pushed conservation agricultural methods.

Conservation Agricultural Principles (Bhan, S., And Behera, U. K.) (2014)

Conservation agriculture, as a strong strategy for managing natural resources and achieving agricultural sustainability, should be adopted to improve Resource Use Efficiency (RUE) and crop yield.

1. Mechanical soil disturbance is kept to a bare minimum: The biological activity of the soil creates extremely solid soil aggregates as well as holes of varied sizes that enable air and water to pass through. This is referred to as "biological tillage," and it differs from mechanical tillage. The biological soil structuring activities will vanish as a result of mechanical soil disturbance. Minimal soil disturbance ensures optimal proportions of respiration gases in the rooting zone, moderate organic matter oxidation, porosity for water flow, retention, and release, and minimises weed seed re-exposure and germination (Kassam and Friedrich, 2009).

2. Organic soil cover that is permanent: A permanent soil cover is necessary to protect the soil from the damaging effects of rain and sun, to provide a constant supply of “food” to the micro and macro-organisms in the soil, and to change the microclimate in the soil for optimal growth and development of soil organisms, including plant roots. As a result, soil aggregation, biological activity, biodiversity, and carbon sequestration improve (Ghosh *et al.,* 2010).

3. Crop rotations using a variety of crops: Crop rotation is important not only to provide a diversified “diet” for soil microbes, but also to investigate different soil strata for nutrients that have been leached to deeper levels and may be “recycled” by the crops in rotation. In addition, a diversified crop rotation results in a diverse soil flora and fauna. Through life cycle disruption, biological nitrogen fixation, off-site pollution management, and biodiversity enhancement, legume cropping sequences and rotations assist to keep insect population growth to a minimum (Kassam and Friedrich, 2009).

Conservation Agriculture's Advantages: (FAO, 2012)

1. Benefits to the economy:

a. Increased production efficiency, i.e., greater output for less input.
b. Reduced labour requirements due to time savings and Cost reductions, such as fuel, machinery running and maintenance expenses, as well as labour costs.

2. Agronomic advantages:

a. They boost soil production.
b. Soil productivity improves when conservation agriculture is practiced.
c. Rise in organic matter and Water conservation in the soil.
d. Improved soil structure and, as a result, rooting zone.
e. Adding agricultural leftovers on a regular basis increases the organic matter content of the soil.

3. Environmental advantages: That safeguard the soil and increase the sustainability of agriculture:

a. Lowering the expense of maintaining roads, dams, and hydroelectric power plants by reducing soil erosion.
b. Improving the quality of the water and air and Increased biodiversity.
c. Carbon sequestration is a term used to describe the process of removing carbon from the atmosphere
d. Residues on the soil surface diminish the splash-effect of raindrops, and once the raindrops' energy has gone, the droplets fall harmlessly to the ground. As a result, there is more infiltration and less runoff, resulting in less erosion.

Constraints to Conservation Agriculture Adoption

1. Inadequate seeders, particularly for small and medium-scale farmers: Despite substantial progress in creating and promoting machinery for seeding wheat in no-till systems, widespread adoption will necessitate a greater focus on developing, standardising, and promoting quality gear for a variety of crops and cropping sequences. These would entail the creation of permanent bed and furrow planting techniques as well as agricultural residue harvesting activities.

2. Widespread use of agricultural leftovers for animal feed and fuel: Farmers confront a scarcity of crop residues, particularly in rainfed areas, due to lower biomass output of various crops. For agricultural residue, there is a rivalry between conservation agriculture and animal feeding. This is a significant impediment to the development of conservation agriculture in rainfed areas.

3. Burning crop residues: Farmers prefer to seed the following crop on time by burning the residue since they do not have technology for sowing in conservation agriculture systems. In north India, this has become a typical component of the rice-wheat system. This has negative consequences for the region's ecology.

4. Lack of awareness among agriculture leaders, extension agents, and farmers about the potential of conservation agriculture: This means that a wide range of conservation agriculture practises, such as planting and harvesting, water and nutrient management, disease and pest control, and so on, must be evolved, evaluated, and matched in the context of new systems.

5. Skilled and scientific manpower: Managing conservation agricultural systems would necessitate increased scientists' abilities to approach challenges from a systems viewpoint and to collaborate closely with farmers and other stakeholders. Knowledge and information sharing systems must be strengthened.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Space Agriculture

Article ID: 12123

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Introduction

India has made a successful Mars mission and like every other nation even India is trying to search whether life is possible in space *i.e.,* either on moon or any other planet like the Red Planet Mars. In order to survive in long term space mission man has to come with permanent solutions like growing his own food in space. Space farming refers to the food crops cultivation for food and other allied activities in space or on off-Earth celestial objects – like agriculture on Earth.

Farmers or crew members are going to face biggest challenge of growing food in space. Biophysical challenges like microgravity or zero gravity, low atmospheric pressures, and very high CO_2 concentrations, higher temperature, etc. Space agriculture is classified in to two types' space farms on spacecraft and space farms on planetary surfaces. The space farm modules are going to be built as flight hardware because they're going to be employed by manned-crews in space. However, there are large difference between spacecraft and planetary bases whether it is availability of resources for cultivation of food crops and other constraints. Therefore, space farming will require controlled environment chambers of different sizes and power demands depending on the available local resources (Monje *et al*., 2003).

The basic issue in space is habituation to supply adequate food to the human crew member as vegetables or food packets won't be sufficient for long duration mission. Historically, human has consumed animal meat for long time; he will need it in space too. It's impossible to carry, breed and domesticate large meat purpose animals practically. Insect being light weight and easy to carry can provide vital supplements, energy and would be easy to breed in space. Human has known insect as a human food that is Entomophagy according to the evidence from the fossilized feces. Scientists have proposed insect which are consumable and complementary to plant culture such insects are proposed by scientists which can be used as food supplement in space (Katayama *et al*., 2008).

Brief Review of Plant Growth System in Space

Plant Growth Systems in Space: The soviet Salyut stations were the first crewed space stations and were the predecessors of the MIR space station and International space stations (ISS). Salyut 1 was launched in 1971 and several Salyut programs continued experimenting many plant experiments and improving with every successive mission.

The first Soviet Union flight experiment was the Oasis 1 plant growth system. The success of this experiment was observed in Oasis 1M in which peas and onion were grown. Pea plants could not grow and continue on the other hand onion grew well till 20 cm height this made onion first successful vegetable grown in space till date. Improvements were made in design of the system with every next experiment Oasis 1 A was capable of providing increased aeration to the root zone.

Other experiment of Salyut space stations was Vazon, unlike Oasis there was no seperate lighting system used in Vazon. Some experiments were conducted with flowering plants like orchid, tulip plant to help crew (group of people on space mission) to cope up with their depression in Vazon and Malachite. Malachite was the primary experiment specifically designed to research the psychological benefits of crew interaction with plants.

Biogravistat was a mission to investigate the effects of microgravity on higher plants. It was one-foot-wide star fish shaped and was able to rotate and simulate different level of gravity. Application of magnetic field around Biogravistat made it Magnetogravistat. Svetoblok was the first plant growth system capable of growing plants in sterile environment. Phyton series was advanced system among all Salyut program which had very powerful lamp, a nutrient medium and a filter to extract air contaminants. Phyton series made a major achievement in growing plants from seed to seed in space.

VEGGIE food production system is NASA's latest achievement launched in 2014. It is the primary designed for food production instead of plant experiment under microgravity. It has 0.17 m2 root mat spacing as growing area and from 5 to 45 cm height with red, blue, green LED used as light subsystem. The panel provides light illumination at 300µmol m-2s^{-1} to plants and the bellows spate the cabin atmosphere and plant growth chamber atmosphere and maintain elevated humidity.

Plant Growth Systems in Space: Table 1: Overview of plant growth chambers in space (Zabel *et al.*, 2016):

Salyut Space Stations	Mir	Space Shuttle	International Space Station (ISS)
Oasis series	SVET	Plant Growth Unit (PGU)	Advanced Astroculture (ADVASC)
Vazon	SVET-GEMS	Plant Growth Facility (PGF)	Biomass Production System (BPS)
Malachite	Vazon	Astroculture (ASC)	European Modular Cultivation System (EMCS)
Biogravistat/ Magnetogravistat	Svetoblok	Plant Genetic Bioprocessing Apparatus (PGBA)	Plant Experiment Unit (PEU)
Svetblok	Astroculture (ASC)	-	Advanced Biological Research System (ABRS)
Phyton series	-	-	VEGGIE

Table 2. Details of experiment and their notable information (Zabel *et al.*, 2016):

Experiment	Spacecraft	First launch	Notable information
Oasis 1	Salyut 1	1971	first plant growth system in a crewed spacecraft
Oasis 1M	Salyut 4	1974	produced first space grown crops (onions) eaten by humans
Oasis 1AM	Salyut 6	1977	-
Oasis 1A	Salyut 7	1982	-
Vazon	Salyut 6/ 7;Mir	1973	first ornamental plants
Malachite	Salyut 6	1973	first psychological investigations of human-plant interactions
Biogravistat or Magnetobiostat	Soyuz 22; Salyut 6/7	1976	centrifuge to simulate different gravity levels; application of magnetic fields to plants
Svetoblok	Salyut 7; Mir	1982	first flowering of plants in space
Phyton experiment	Salyut 7	1982	first successful seed-to-seed
VEGGIE	ISS	2014	first plant growth system purposed for investigating food production in space

Entomophagy: A Key to Space Agriculture

Space agriculture should be self-sustaining which is necessary for survival. Every molecule produced or carried in space is valuable and cannot be wasted. Nutritional requirement and the content of food are to be considered in the spare agriculture system. About 75% of Earth population is insects. Insects have ability to survive in adverse environment; they can be easily bred, are light weight so easy to carry and requires small space. Most important human has consumed insects as a part of food and they don't taste bad most likely taste same as lobster crab and shrimp. Insects have played an important role in pollination of some species therefore; it is important to understand natural interaction. The importance of having insects in space environment is they don't compete with humans for food or for any other resources and are able to convert inedible biomass into edible food (Katayama *et al.*, 2008).

For space agriculture it is important to study some insect species like silkworm (*Bombyx mori*), the hawkmoth (hornworm), (*Agrius convolvuli*), the drugstore beetle (*Stegobium paniceum*) and the termite (*Macrotermes subhyalinus*).

Silkworm is known and reared for a long by human. Human has learned the techniques and methods of rearing silkworm for commercial purpose. In East Asia both larvae and moth are consumed as snacks. Silkworm has the ability to convert inedible mulberry tree leaves into edible besides its waste product can used as a manure to improve soil fertility as well as a fish feed. Silkworm is long known for its production of silk for cloth purpose.

Hawkmoth feed on sweet potato leaves though sweet potato leaves can be consumed to human. In size this insect is larger than silkworm and has ability to convert 65% of nitrogen from leaves to protein which helps in increasing nutritional value.

Symbiotic protozoa in guts of both termite and pharmacy beetle can produce required cellulose; this cellulose is converted into sugars which can be utilized by insects. Thus, both termite and drugstore beetle are capable of converting cellulose to animal biomass.

Conclusions

1. Growing of vegetable and food on spacecraft and ground based prototype is possible but not in large scale.
2. The gap between the proposed food and actual food can be grown in space is to be filled.
3. More research is needed to be conducted on insects as food in space.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Scientific Cultivation of Makhana

Article ID: 12124

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Introduction

*Euryale ferox*salisb is an important aquatic crop, belong to family Nymphaeaceae is commonly known as Makhana, Gorgon nut or Fox nut,and grown in stagnant perennial water bodies like ponds, landdepression, swamps and ditches. Makhana seeds are also known as black diamond. Bihar is the leading producer of makhana accounting for more than 85% of the total production of India.Madhubani, Darbhanga, Sitamarhi, saharsa, Katihar, Purnia, supaul, kishanganj and Araria districts are the major producers of Makhana in the State. Area under Makhana cultivation is about 13000 ha.

Makhana has floating leaf and emergent macrophyte. The leaves are orbicular, floating and glabrous, green and corrugated above and deep purple beneath, supported by stout, porous and prickly ribs. The chemical constituents of the popped kernels (g/100 g) are 12.8 g moisture,76.9 g carbohydrate,9.7g proteins,0.1 g fat,0.5g total minerals,0.02 g calcium,0.9 g phosphorus and 0.0014 g iron which makes it comparable to dry fruits such as almond, walnut, cashew nut and coconut. Makhana is recommended for treatment of diseases regarding respiratory, circulatory, digestive, excretory and reproductive systems.

Cultivation of makhana has immense potential for enhancing the economic status of farmers. Makhana cultivation and production should be recognised as an industry. The diversification from high volume low value crop to low volume high value crop may also increase farmers income as well as job opportunity for rural youth.

In such a scenario, makhana could be saviour for the farmers of this region, with huge abundance of low land areas and relatively higher rainfall during kharif season.

Crop Cultivation

Makhana is cultivated in perennial water bodies/ponds having water depth of 4-6 ft or in field system having depth of 1-2 ft.

Pond System

It is the traditional system of makhana cultivation. Seed sowing is not required since left over seeds of the previous crop serve as a planting material of subsequent crop. For direct sowing requirement of seed is 80-90 kg/ha.When Plantlets come out to the upper surface of water. At this stage optimum distance of 1x1 m is maintained by the thinning of extra plants.

Field System

This system of makhana cultivation has been standardized by ICAR Research Complex for Eastern Region. Makhana cultivation is carried out in agricultural fields at a water depth of 1 ft. This system is very easy to operate and provides opportunities to cultivate singhara and cereals in same piece of land.

For sowing, the field is well prepared by two-three deep ploughing. Before ploughing, for proper nourishment of seedlings, fertilizers @100:60:40/ha, respectively, of N, P and K is applied. The field is filled with water up to the 1.5 ft height of bund and the seeds are sown in the month of December.

An amount of 20-25 kg of healthy seeds is broadcasted uniformly in the entire field. For transplanting in one hectare area, about 500m^2 of nursery is found to be sufficient. By the end of March seedlings are ready for transplanting.

Harvesting

The flowering and fruiting start from the month of May and it continued up to October-November. Upon Maturity, the fruits start rupturing and floating on the upper surface of the water. Harvesting refers to the collection of scattered seeds from bottom of pond/field. The field system takes lesser time and gives higher yield as compared to traditional method of pond system.

E-ISSN: 2581 - 8317

Cleaning and Storage

The collected seeds are put in a crescent shaped container known as gaanja which is shaken repeatedly by touching water surface, until all the seeds get cleaned. After proper cleaning seeds are put in gunny bags. The seed yield in Pond system is 1.4-2.2 t/ ha, while in field system the yield potential has been recorded to be 2.6- 3 t/ha.

Post-Harvest Management

The popping process is highly skilled, tedious, time consuming. Post-harvest technology involves sun drying, size grading, pre-heating and tempering and popping, polishing, grading and packaging.

Sun Drying and Size Grading

The moisture content of seeds is reduced to an extent of 25% (w.b.) with the help of sun drying. The entire gradation process requires the sieves of 7 different sizes, marked with No.1-7. while no.1 devise has the largest diameter of pores (1.2 cm), no.7 has the least diameter (0.4 cm). Gradation starts by using No.1 sieve and ends with sieve 7. The entire process is operated manually.

Pre-Heating and Tempering

Sun -dried seeds are heated in earthen pitcher by placing them over the fire and stirring them continuously. The storage of pre-heated seeds for duration of 48-72 hrs at the ambient condition is known as the tempering of the seeds.

Roasting and Popping

Pre-heated and tempered seeds are taken and roasted in a cast iron pan in single layer over the fire at 290-340^{0}c surface temperature with continuous stirring. The roasted seeds are scooped quickly on a hard surface and beaten by the wooden hammer.

Polishing and Grading

Makhana are polished by rubbing action among them in a basket made of bamboo splits. This operation facilitates more whiteness and lusture to makhana. The popped makhana is generally graded in two grades at the producer level-lawa and thurri. The lawa is swollen and white with reddish spot, thurri is semi-popped, hard and reddish in colour.

Packaging and Storage

Makhana is less perishable. Therefore, ordinary gunny bags for local markets and gunny bags with polythene lining are used for distant markets. Makhana can be easily stored under ordinary storage conditions for long periods.



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E-ISSN: 2581 - 8317

Nanotechnology: A Novel Approach in Pest Management

Article ID: 12125

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Introduction

Application of pesticides have been successful pest management however due to indiscriminate use of pesticide pest resistance; resurgence problems are arising now a days. It is also having ecological and environmental hazards. Hence to reduce the pesticide load in the environment, now the recent era is focusing on the use of pesticides based on nanotechnology *i.e.,* Nanopesticides. The term "nanopesticides" is used to describe any pesticide formulation that (a) intentionally includes entities in the nanometer size range. Therefore, researchers involved in IPM have shifted their attentions towards the development of new eco-friendly nanopesticides. The enhanced efficacy of nano pesticides at low concentrations can benefit the farmers and reduce the pollution level in the environment.

Types of Nanoparticles Used in Pesticide Formulations

1. Nanosphere.
2. Nanocapsules.
3. Nanogels.
4. Micelles.
5. Matrix capsulation.
6. Microencapsulation.

Uses of Nanoparticles

1. A series of nano emulsions of neem oil has shown that LC50 decreased with the droplet size (Anjali *et al.,* 2012).
2. Insecticidal activity of silica nanoparticle formulation was twice as high than that of commercial insecticides.
3. Kah *et al.,* (2014) had done an experiment with Electrospun nanofibers and found that Thiamethoxam was efficient at 50% of the recommended dosage against whitefly under glasshouse condition.

Advantages of Nanopesticide Over Conventional Pesticides

1. Delivery efficacy of agrochemicals increases as a result the pesticide residual effect is minimised.
2. Enhancing the bioefficacy, reducing the chemical input to plants, solving the problem of non-target toxicity
3. Improves chemical stability for light sensitive compounds by restricting photodegradation.
4. It is eco-friendly and cost effective.

Conclusion

The strategy of the use of nano-formulations is interesting, since it can help to mitigate adverse impacts of agrochemicals on the environment and to the human health. As a result, there has been a substantial increase in research activity in this area. Still, more works needs to be carried on in this field to improve the pesticide application efficacy keeping in mind the ecological safety.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Organic Matter - An Important Component for Soil Management

Article ID: 12126

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Introduction

Soil organic matter (SOM) is a key indicator of soil quality. It exerts a major influence on a number of physical, chemical and biological properties of soil that determine soil health or soil quality. Soil organic carbon (SOC) has a good relationship with crop yield. Higher the SOC content, higher is the yield. Increasing SOC stock by 1 Mg C ha^{-1} in the root zone can increase crop yield by 15-33 kg ha^{-1} for wheat, 160 kg ha^{-1} for rice, 170 kg ha^{-1} for pearl millet, 13 kg ha^{-1} for groundnut, 18 kg ha^{-1} for lentil, 90 kg ha^{-1} for sorghum, 101 kg ha^{-1} for finger millet and 145 kg ha^{-1} for soybean. It also maintaining or enhancing SOM, besides being important for minimizing risk of soil degradation is crucial for ensuring national food security. Adoption of improved management practices such as residue recycling and integrated use of inorganic fertilizers and organic manures enhance soil quality and production system sustainability.

Organic C Stocks in Soils

Carbon in soil exists in organic (soil organic carbon: SOC) and inorganic (soil inorganic carbon: SIC) forms; total carbon being the sum of both. Inorganic carbon in the soil occurs mainly in carbonate minerals, such as calcium carbonate ($CaCO_3$) and dolomite (Ca Mg $(CO_3)_2$). Large concentrations of carbonates are typical for soils, which have developed on calcareous parent materials and under arid or semiarid climate. Globally, soils stock about 1500-2400 Gt C to a depth of 1 m in various organic forms ranging from recent plant litter to charcoal to very old humified compounds and 800 to 1000 Gt as inorganic carbon or carbonate carbon. Estimates of SOC pool in India range from 24 to 63 Gt to 1.5 m depth. Based on the geographical distribution of soils throughout the country, SOC stock in different physiographic regions of India was estimated to be 21 Gt to 0.3 m depth and 63.2 Gt up to 1.5 m depth. Accumulation of organic C in soil is related to climatic conditions (temperature and precipitation), with humid conditions and low temperature favouring accumulation of organic C in soils. In general, cultivation of undisturbed soils causes depletion of SOC stocks. There has been a decrease of 30 to 60 percent in SOC concentration of cultivated soils in India. This is because cultivation leads disruption of aggregates and reduces the proportion of macro - aggregates compared to uncultivated soils.

Climate Change and Need to Sequester C

The atmospheric concentration of carbon dioxide (CO_2) has increased globally by 40 percent from 278 ppm in the pre-industrial era to 390.5 ppm in 2011.and to current 398 ppm. During 2002-2011, the atmospheric CO_2 concentration increased at a rate (2.0 ± 0.1 ppm yr^{-1}) higher than any previous decade since direct measurements of atmospheric concentration commenced in 1958. About 2/3rd of the anthropogenic CO_2 emissions come from the combustion of fossil fuel (375 ± 30 Pg C) and the remainder (180 ± 80 Pg C) is contributed by land-use changes. The global C budget shows that compared to atmospheric increase of 3.1 Gt C yr^{-1} in1990s the atmospheric load increased at a rate of 4.3 Gt C yr^{-1} during the years 2002 to 2011. Globally, soils have lost an estimated 55-78 Gt C because of land-use changes: therefore, soils have considerable capacity to sequester C and mitigate atmospheric C load. However, the rate and magnitude of soil C sequestration differs with factors such as soil quality, antecedent C level, climatic conditions, land-use, and management.

Soil Organic Matter Response to Land-Use

Soil organic C stocks are strongly influenced by land-use and any misuse of soil can lead to soil degradation. Soils under forests normally stock the highest amount of C followed by grasslands and croplands. In the foothills of Indian Himalayan region, top half a meter soil under forest had the highest (47.5 Mg ha^{-1}) SOC stocks followed by horticultural systems (42.4 Mg ha^{-1}) and agricultural lands (35.1 Mg ha^{-1}). TOn the contrary, conversion of cropland to forest or grassland can lead to build-up of SOC. In the western Himalayas of India, SOC stocks were greater in natural ecosystem such as forests and pastures (112.5-

247.5 Mg ha^{-1}) than agriculture (63-120.4 Mg ha^{-1}) (Singh *et al.* 2011). Therefore, forest plantation in temperate conditions of Western Himalayas in India provides large potential to sequester C.

Soil Organic Matter Response to Management

Management practices that create positive ecosystem budget led to net C sequestration in soils. This could be achieved by increasing C input and decreasing soil C loss. Increased C input in agro-ecosystems can be achieved either through external supply such as addition of organic amendments or by augmenting plant-mediated C input through adoption of management practices that increase productivity and resource use-efficiency. Carbon loss from agricultural soils could be lowered by adopting practices that reduce rates of organic matter decomposition, such as adopting conservation agriculture, minimizing soil disturbance, checking erosion and using low quality organic inputs.

Intensive Agriculture: Intensive agriculture with improved nutrient and water management can increase water and nutrient use efficiency and crop biomass production, thereby increasing plant-mediated C input to soil and reducing rates of organic matter decomposition. In Punjab, intensification of agriculture with rice-wheat system improved SOC by 38 percent over a 25-year period. The enhanced C sequestration resulted from increased productivity of rice and wheat.

Nutrient Management and Organic Matter Recycling: Application of recommended amounts of fertilizers leads to C sequestration by increasing crop productivity and nutrient use-efficiency. Balanced application of N, P and K fertilizers across several sites in India improved SOC concentration by 6 to 100 percent and C sequestration by 20-600 kg C ha^{-1} yr^{-1} depending on soil, crop and climatic conditions. Integration of inorganic fertilizers with organic amendments further enhances soil C sequestration. Integrated use of organic sources, such as farmyard manure (FYM) and inorganic fertilizers enhanced SOC concentration by 17 to 100 percent and C sequestration by 100-1200 kg C ha^{-1} yr^{-1} under various soil, crop and climatic conditions in India

Conservation Agriculture and Crop Residue Recycling: Conservation agriculture (CA), which aims at enhancing natural biological processes through reduced soil tillage and optimum application of organic and inorganic fertilizers and agrochemicals, has been suggested as a strategy to minimize C emission and enhance C sequestration. Physical disturbance associated with intensive soil tillage increases the turnover of soil aggregates and accelerates the decomposition of aggregate associated C. No-rill (NT) practices increase aggregate stability and promote the formation of recalcitrant C within stabilized micro- and macro- aggregates.

Soil Organic Matter to Land-use and Management

Land-use and management influence not only the quantity but also quality or composition of SOM. Soil organic matter is generally characterized by chemical, physical, biological or biochemical fractionation techniques. Chemical fractionation methods are mostly based on the solubility and affinity of certain organic C compounds in different solvents or extracting solutions. The most commonly used extracting solution is 0.5 M NaOH. The extracted solution is further separated by selective precipitation, solvent affinity, chromatographic, electrophoretic and size exclusion techniques. Alternatively, specific structural components and functional groups of organic C are identified and measured by applying techniques such as infrared (IR) and ultraviolet spectroscopy or nuclear magnetic resonance (NMR), *etc.*

Climate Change and Soil Organic Matter Turnover

Soil organic matter can both be a source and sink of atmospheric CO_2, depending on the input-output balance. A soil source results when net decomposition exceeds C inputs to the soil, either as a result of human activities or because of increased decomposition rates due to global warming. Changes in climate are likely to influence the rates of accumulation and decomposition of SOM, both directly through changes in temperature and water balance and indirectly through changes in primary productivity and rhizodepositions. Soil organic matter shows both quantitative and qualitative responses to land-use and management. The rate and magnitude of response differs with soil type, climatic conditions and input of C. Management practices that create positive ecosystem budget led to net C sequestration in soils.

AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Cashew Leaf Twisting Weevil: Biology, Nature of Damage and its Management

Article ID: 12127

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Introduction

Leaf twisting weevil, *Apoderus transquebaricus* Oliver (Attelabidae : Coleoptera) is considered as a minor pest in Cashew (*Anacardium occidentale* L.) but in the changing pest scenario, it is observed as one of the important sporadic pests of cashew, found on nursery and main field. Both Cashew and Mango (*Mangifera indica* L.) are two important commercial tree species belong to Anacardiaceae family, and share few pest species commonly during their phenological stages (Vanitha, 2020). *A. tranquebaricus* feed on the *Mangifera indica*, *Anacardium occidentale* and treated as sporadic pest. (Prem Chand, 1995 and Ayyar, 1940). *A. tranquebaricus* in South India rolls the leaves of Country almond, *Terminalia catappa* and habits have been observed on the number of species in the subtropical zone of India. Over 30 species are known from India in the genera *Apoderus, Attelabus and Rhynchites*. (Lefroy, 1909). Earlier, attempts were made to describe the biology of this weevil by Fletcher, 1914 and Butani,1993. Biology, Nature of damage of pest is highly essential to understand the changing pest scenario during different crop phonological stages and accordingly pest management efforts need to be planned.

Identification Characters

1. The adult weevil medium sized, reddish brown with a long snout and has the habit of cutting and twisting the cashew leaves into shapely thimble like rolls which remain attached to the parent leaves.
2. The grub feeds on the leaf tissue within the leaf roll and pupates within.
3. Eggs are laid in each leaf roll.

Host Range

Syzygium cumini, *Dimocarpus longan*, *Aporosa lindliyana*, *Mammea suriga*, *Terminalia tomentosa*, *Terminalia arjuna*, *Terminalia catappa*, *Mangifera indica*, *Lagerstromia* sp., *Grewia* sp. (Mamlayya *et al*.,2011).

Biology, Breeding Habit and Life Cycle

	
Fig.1.Eggs of Leaf twisting weevil	**Fig.2a. Rolled leaf after careful opening**

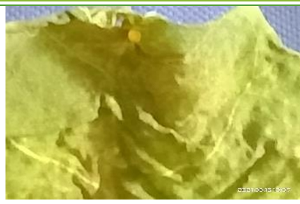

Fig 2b. Single egg laid on the tip of the leaf margin

Fig.3. Different grub stages

Fig.4. Grubs before pupation

Fig.5. Adult - Leaf twisting weevil

Fig.6. Adult wandering on cashew leaf

Egg

The eggs are pale yellow colour, shiny and oval in shape (Fig. 1). The eggs were laid singly in the peripheral region within the twisted leaf (Fig 2a and 2b). In the initial period of egg laying, the eggs were surrounded by mucilaginous substances secreted by the adult female to stick on to the leaf surface. The egg period is 4 days.

Grub

After hatching from egg, the neonate grub starts to feed on the leaf inside the leaf cradles. Grubs are apodous, Body with sparse to abundant setae; thorax slender than abdomen. Head is yellow. The larva moults twice. Grub stage of the leaf twisting weevil consists of early and late grub stages. During the early stage, the grubs were small, sluggish in movement and were pale yellow in colour without legs. In the matured stage, the grubs were yellowish colour, 'C' shaped with black small sting like structure and actively feeding on the twisted region of the leaf (Fig.3). The grub stage lasted on an average of 12.3 days with the range of 10.7 – 15.7 days (Manjunath and Umamaheshwari, 2018).

Pupa

The pupal stage is inactive stage and occurred in the inside the leaf roll. Pupal period is 5 to 8 days. The pupa was pale yellow in colour(Fig.4).

Adult

Adults Leaf twisting weevils were medium in size reddish shiny reddish brown in colour with long neck and snout. The snout region was narrow and abdomen was broader and the adult weevil had triangular shaped body (Fig.5 and 6), Head possessed long neck and was broader than neck; proximal part of head showed rostrum (or) snout which was reddish brown in colour. Length and width of neck varied from male and female. Neck was shorter in male and larger in female. The matured adult females were bigger in size than the male ones. The average adult longevity is 17 days. The fecundity of females ranged from 30 to 59 eggs.

After the mating, the female prepares the cases of green leaves. The cut reaching from each margin only the leaf then folded longitudinally and the tip rolled and forms a compact cylindrical mass, tightly rolled and folded leaf blade with the egg in the centre (Fig.2a). The biology of leaf twisting weevil results is supported by Fletcher, 1914; Singh and Thangavel,1990. One Peculiar character was observed, when slightly disturbed, it moves to the next twig by flying. It can even fly upto 20 metres in one take off. Very good flyer even flies upto 10 to 15 feet height.

Crop Damage, Characteristic Symptoms

Fig.7. Compact thimble-shaped structure

Fig.8. Severe damage seen on one twig

Fig.8. Besides Ash weevil, Leaf miner, shoot and blossom webber damage is being made, Leaf twisting weevil is still doing her job.

Adults cut across a leaf from margin to midrib near base. Leaf is then folded longitudinally from tip downwards and a compact thimble-shaped structure is formed (Fig.7 and 8). Roll gradually starts drying and ultimately falls down along with pupa.

Adults come out by making a small hole in dried, rolled mass of leaf. Female adult Leaf twisting weevil never bothers about the other species complex occurred in the new flushes, she simply starts her work in folding, cutting, twisting the leaves and making cylindrical rolls in the new flushes of cashew, by the way she makes enough parental care for future generation (Fig.9).

Favourable Season

Leaf twisting weevil, *A. transquebaricus* on cashew was observed during second week of August to January. The peak incidence was recorded during Third week of September in Cuddalore district of Tamil Nadu.

Management

Under severe incidence in nursery and young plants as well as in the mail field, spraying is required. Spraying of Chlorpyriphos @ 2 ml/lit. of water or Profenophos @ 2 ml/lit.0f water are found effective in managing this pest. During spraying, wetting agent @ 1 ml/lit.of water should be added to provide stickyness to the leaf.

Conclusion

Cashew leaf twisting weevil is one of the sporadic pests especially during post monsoon and flushing period all over the country and very commonly noticed on nursery and young plants and leaf twigs of cashew plantations during August and September in Cuddalore Disrtict of Tamil Nadu. Its feeding causes extensive leaf rolls, which later dried leaf rolls resulting in loss of photosynthesis and foliage loss ultimately leads to loss of flowering twigs. Severe infestation of leaf twisting weevil in young seedlings and cashew plantations requires spraying.

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Post-Harvest Management of Underutilised Pomelo

Article ID: 12128

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Introduction

Pomelo is the largest member of the citrus (Rutaceae) family and genus citrus. Pomelo is one of the underutilised fruits wildly available in plenty in the hillock of North eastern part of India. It is a juicy fruit yellow greenish in appearance with succulent white and pink colour pulp having high nutraceutical and medicinal value. Due to lack of knowledge on processing lots of fruits goes wasted every year. Pomelo (Citrus grandis (L.) Osbeck) is the largest citrus fruit, with a diameter of more than 12 inches with yellowish or greenish skin, white or pinkish flesh and has a sweetish-acidic favor. Since ancient times, its pulp has been used as appetizer, antitoxin, cardiac stimulant, and stomach tonic. The fruit extract is reported to possess a variety of pharmacological benefits including antioxidant, antimicrobial antiobesity, and antidiabetic properties. Abundant in potassium, phosphorus, folic acid, vitamins B1, B2, and B12, protein, and water. It is a rich source of vitamin C and antioxidants (beta-carotene, terpenoids, alkaloids, betasitosterol, carotene, polyphenols, and favonoids as well as favone glycosides) Neohesperidin, hesperidin, naringenin, naringin, and rutin are among the common flavonoids. Human beings cannot synthesize vitamin C. We need to take it in our diet and being water soluble, its constantly eliminated from our body. Vitamin C in human diets is supplied by fruits and vegetables. RDA- 85-90 mg. Through processing it can made available whole year. Pomelo is one of the underutilised fruits wildly available in plenty in the hillock of Chandel district. Due to lack of knowledge on processing lots of fruit goes wasted every year. It is highly perishable; the shelf life can be extended by the process of preservation and value addition. For doubling farmers income, GOI give more emphasize on processing of the underutilised fruits

Health Benefit of Pomelo Fruit

1. Pomelo fruit has antioxidants and flavanoid contents which help to fight against cancer and inflammation effectively.
2. The Vitamin C present in pomelo helps to boost immune system, which helps to fight against cold, flues and other common infections.
3. It contains low fibre, high water content, high mineral and high fibre which helps in weight reduction.
4. It helps to maintain normal blood pressure and heart.
5. It helps to improve iron absorption, aids in digestion and boost milk production in women.
6. It helps in preventing cardio-vascular diseases, atherosclerosis and help to reduce cholestrol level.
7. It helps to make skin more radiant and help to rid of fungal infection.
8. It helps in boosting immune system, stimulating lactation, detoxifying the body, relieving respiratory distress and aiding in weight loss.

Nutritional Value of Pomelo Fruit Per 100 Gm. of Edible Portion

Nutrient	Nutrient Value
Energy-231.0 Kcal	Magnesium -1%
Total fat-0.2gm	Potassium- 216mg
Vitamin C-116 mg	Protein -4.6 gm
Moiture -91.9 gm	Sodium -6.1 mg
Total carbohydrate-59 gm	Fibre - 6

Flow Chart for Juice Extraction

Fresh fruits
↓
Peel off outer inedible casings or peels
↓

Chopped the inner part into halves, remove the flesh

↓

Pressed the fruit using squeezer/ juicer

↓

Filter the fruit juices by muslin cloth

↓

Centrifugation at 6000 rpm at 4 ˚C for 5 min

↓

Supernatant/ Fruit juice

Pomelo fruit

Processing of RTS

For RTS preparation select healthy mature fruit. Wash the fruit and peel off inedible caching or peels. Chopped the inner part in to halves, remove the flesh and pressed the fruit by using squeezer/ juicer and filter the juice in strainer or muslin clothe. Sugar, citric acid, juice and KMS are weighed separately and water is also measured according to required amount. Then sugar, citric acid and water are heated to boil and then strain through a filter. The syrup is cooled and mixed with the juice and remaining water and mixed it properly. Then KMS is dissolved in small quantity of water and add to RTS. After mixing properly it is finally poured into sterialised bottle.

Processing of Chutney

Select fresh mature fruit, washed and peeled off inedible caching or peels. Chopped the inner part in to halves, remove the flesh. The pulp is extracted from the fruit flesh by using pulp extractor. The extracted pulp is cooked by adding 500 gm sugar and spices till it becomes slightly thick in consistency. Then 10 gm of citric acid is added and cooked it till it reaches chutney consistency or TSS of 68 degrees brisk. Add few drops of red colour to the cooked chutney and fill it hot into sterialised glass bottle and seal properly when it is cooled. Then store it in cool dry place.

Processing of Candy

Select fresh healthy mature fruit and wash it properly with cold water for the preparation of candy. Remove peel from pomelo with a knife. Blanch the peels for about 1 minute. Plunge into an ice bath, rinse off and repeat. Repeat 2-3 times to remove some of the bitternes. Prepare sugar syrup 1:1 water: sugar and add the rinsed peels, turn the heat to low, cover and let cook for 1 hour till it reaches 72-degree brix. Dry in oven at low temperature till it reached 4-8% moiture content. Then coat the candy with sugar powder and dries it properly. Store the product in sterialised dry bottle.

Processing Of Jam

Select fresh, mature fruit, washed and peeled off inedible caching or peels. Chopped the inner part in to halves, remove the flesh. The pulp is extracted from the fruit by using pulp extractor. The extracted pulp is cooked by adding 750 gm sugar till it becomes slightly thick in consistency. Then 10 gm of citric acid is added and cooked it till it reaches jam consistency or TSS of 68 degrees brisk. Add few drops of red colour to the cooked jam and fill it hot into sterialised glass bottle and seal properly when it is cooled. Then store it in cool dry place.

Some of the Value-Added Products from Pomelo

Pomelo chutney with gur and sugar

Marmalade

Pomelo RTS

Conclusion

Pomelo is a highly perishable fruit and it is gone wasted every year. Preservation in the form of value-added product like squash, RTS, chutney, candy and salted dry preserve could extend the shelf life and also made the product available throughout the year, it also adds variety to the diet and also helped to improve the nutritional status of the people. The preserved value-added product could reduce the post-harvest losses to 25% from 75% and can extend the shelf life of RTS up to 3 months, squash up to 6 months and for jam, candy it can be extended up to up to one year. Entrepreneurship on processing and value addition of pomelo could sustain the livelihood of many women by earning income from processed products by providing employment to many farm women which helped to empower many women by improving the economic status of the family, society and nation as a whole. It helps to become financially self-reliant, improve the status of the family in their society, increase influence and acceptability among fellow members, increase material possessions and improve children's educational quality.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Scientific Cultivation of Makhana

Article ID: 12129

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Introduction

Euryale ferox salisb is an important aquatic crop, belong to family Nymphaeaceae is commonly known as Makhana, Gorgon nut or Fox nut,and grown in stagnant perennial water bodies like ponds, land depression, swamps and ditches. Makhana seeds are also known as black diamond.

Bihar is the leading producer of makhana accounting for more than 85% of the total production of India. Madhubani, Darbhanga, Sitamarhi, saharsa, Katihar, Purnia, supaul, kishanganj and Araria districts are the major producers of Makhana in the State. Area under Makhana cultivation is about 13000 ha.

Makhana has floating leaf and emergent macrophyte. The leaves are orbicular, floating and glabrous, green and corrugated above and deep purple beneath, supported by stout, porous and prickly ribs. The chemical constituents of the popped kernels (g/100 g) are 12.8 g moisture,76.9 g carbohydrate,9.7g proteins,0.1 g fat,0.5g total minerals,0.02 g calcium,0.9 g phosphorus and 0.0014 g iron which makes it comparable to dry fruits such as almond, walnut, cashew nut and coconut. Makhana is recommended for treatment of diseases regarding respiratory, circulatory, digestive, excretory and reproductive systems.

Cultivation of makhana has immense potential for enhancing the economic status of farmers. Makhana cultivation and production should be recognised as an industry. The diversification from high volume low value crop to low volume high value crop may also increase farmers income as well as job opportunity for rural youth. In such a scenario, makhana could be saviour for the farmers of this region, with huge abundance of low land areas and relatively higher rainfall during kharif season.

Crop Cultivation

Makhana is cultivated in perennial water bodies/ponds having water depth of 4-6 ft or in field system having depth of 1-2 ft.

Pond System

It is the traditional system of makhana cultivation. Seed sowing is not required since left over seeds of the previous crop serve as a planting material of subsequent crop. For direct sowing requirement of seed is 80-90 kg/ha. When Plantlets come out to the upper surface of water. At this stage optimum distance of 1x1 m is maintained by the thinning of extra plants.

Field System

This system of makhana cultivation has been standardized by ICAR Research Complex for Eastern Region. Makhana cultivation is carried out in agricultural fields at a water depth of 1 ft. This system is very easy to operate and provides opportunities to cultivate singhara and cereals in same piece of land.

For sowing, the field is well prepared by two-three deep ploughing. Before ploughing, for proper nourishment of seedlings, fertilizers@100:60:40/ha, respectively, of N, P and K is applied. The field is filled with water up to the 1.5 ft height of bund and the seeds are sown in the month of December. An amount of 20-25 kg of healthy seeds is broadcasted uniformly in the entire field. For transplanting in one hectare area, about 500m^2 of nursery is found to be sufficient. By the end of March seedlings are ready for transplanting.

Harvesting

The flowering and fruiting start from the month of May and it continued up to October-November. Upon Maturity, the fruits start rupturing and floating on the upper surface of the water. Harvesting refers to the collection of scattered seeds from bottom of pond/field. The field system takes lesser time and gives higher yield as compared to traditional method of pond system.

Cleaning and Storage

The collected seeds are put in a crescent shaped container known as Gaanja which is shaken repeatedly by touching water surface, until all the seeds get cleaned. After proper cleaning seeds are put in gunny bags. The seed yield in Pond system is 1.4-2.2 t/ ha, while in field system the yield potential has been recorded to be 2.6- 3 t/ha.

Post-Harvest Management

The popping process is highly skilled, tedious, time consuming. Post-harvest technology involves sun drying, size grading, pre-heating and tempering and popping, polishing, grading and packaging.

Sun Drying and Size Grading

The moisture content of seeds is reduced to an extent of 25% (w. b.) with the help of sun drying. The entire gradation process requires the sieves of 7 different sizes, marked with No.1-7. while no.1 devise has the largest diameter of pores (1.2 cm), no.7 has the least diameter (0.4 cm). Gradation starts by using No.1 sieve and ends with sieve 7. The entire process is operated manually.

Pre-Heating and Tempering

Sun -dried seeds are heated in earthen pitcher by placing them over the fire and stirring them continuously. The storage of pre-heated seeds for duration of 48-72 hrs at the ambient condition is known as the tempering of the seeds.

Roasting and Popping

Pre-heated and tempered seeds are taken and roasted in a cast iron pan in single layer over the fire at 290-340^0 c surface temperature with continuous stirring. The roasted seeds are scooped quickly on a hard surface and beaten by the wooden hammer.

Polishing and Grading

Makhana are polished by rubbing action among them in a basket made of bamboo splits. This operation facilitates more whiteness and lusture to makhana. The popped makhana is generally graded in two grades at the producer level-lawa and thurri. The lawa is swollen and white with reddish spot, thurri is semi-popped, hard and reddish in colour.

Packaging and Storage

Makhana is less perishable. Therefore, ordinary gunny bags for local markets and gunny bags with polythene lining are used for distant markets. Makhana can be easily stored under ordinary storage conditions for long periods.

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AGRICULTURE & FOOD: E-NEWSLETTER
WWW.AGRIFOODMAGAZINE.CO.IN
E-ISSN: 2581 - 8317

Public-Private Partnerships in Agriculture

Article ID: 12130

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Abstract

This article explains how new practices of public-private partnerships (PPPs) can work for overall development of agriculture sector. As we know that the public sector provides a promising organized atmosphere for the agricultural development and also provides funds for research with local relevance. On the other hand, private sector having substantial capability in product development and distribution.

But there are some effective ways through which the public and the private sector could work together and jointly improve agricultural sustainability. Under Public-Private Partnerships, it can be supposed to offer public organizations access to private-sector properties, including pioneering scientific expertise and technologies for overall development of agriculture sector.

Introduction

Green Revolution made great progress in agriculture sector during the 1960s and 1970s. Companies and public sector organizations around the world continue to achieve breakthroughs in many areas that contribute to global food security.

Nonetheless, yields in key crops still vary significantly between farming regions, and often remain far below their optimal potential. Crop losses pre- and post-harvest continue to prevent an estimated 40 percent of agricultural produce from actually reaching the marketplace (Oerke *et. al.*, 1996). There are many reasons for these shortfalls, but one frequent cause is farmers' lack of access to technology, adequate extension services and poor market integration (Marco and Paul, 2011).

Conventionally, the public and private sector have tried to provide solutions distinctly, with the exception of certain sections in the long path from basic research to well-known sustainable organization where partnership was necessary. Agriculture sector is a knowledge and resource intensive sector. So for sustainable development of the sector, special emphasis must be needed. Public sector in this context has the lack of resources, so for sustainable development, involvement of private sectors proving as benefited now a day.

Public Private Partnerships

PPPs are a popular type of collaboration in many sectors of the economy around the world. In one form or another, partnerships between public institutions and private individuals or organizations have existed for centuries. Public Private Partnership is a cooperative arrangement between one or more public and private sectors, typically of a long-term basis.

Government have used such a mix of public and private endeavors for various public interest project. It is a contractual agreement between a public agency (Federal, state or local) and a private sector entity. Though this agreement, skills and assets of each sector (public and private) are shared in delivering service or a facility for the use of a general public. In this partnership each party shares risk and reward potential in the delivery of the service and/or facility.

The Public Partners in a PPP are government entities, including Ministries, departments, municipalities, or state-owned enterprises whereas the private partners could be local or international and may include business or investors with technical or financial enterprise relevant to the project. PPPs may also include Non-Government Organizations (NGOs) and/or Community Based Organizations (CBOs) who represent stakeholders directly affected by the project.

The Government's contribution to a PPP may take the form of capital for investment (available through tax revenue), a transfer of assets, or other commitments or in-kind contributions that support the partnership. The government also provide social responsibility, environmental awareness, local knowledge, and an ability to mobilize political support. Where the private sector's role is to make use of its expertise in commerce, management, operations and innovation to run the business efficiently. The private partners may also contribute investment capital depending on the form of contract. The structure of the partnership should be designed to allocate risks amongst the partners based on their capabilities to manage those risks and thus, minimize cost while improving performance.

PPPs can take a variety of forms. They are not limited to bilateral collaboration between a government agency and a private corporation. PPP for sustainable agricultural development can also include, for example, multi-partner structures that bring together private companies with entities such as non-governmental organizations (NGO), university research institutes and foundations.

These structures have sometimes been termed "Hybrid Value Chains" that create shared value (Drayton and Budinich, 2010). Broadly PPPs include both these forms and the many other possible for-profit/not-for-profit combinations. Whatever form they take, successful PPPs have a number of features in common. The rationale for their creation is always the same: to achieve more through partnership than any of the parties could do on their own (Braun, 2011).

A PPP in agricultural research and development (R&D), for example, can overcome both the public sector's usually limited ability to take research outputs to market, and the private sector's limited scope for operation where there is no commercially viable market. Contracts, planning, inter-partner relationships and the distribution of tasks within the PPP should all contribute to maximizing synergies between the parties involved. There is also a growing realization of the value of PPP in agriculture, and particularly for projects that benefit farmers in developing countries.

A pillar of PPP success is transparency. Partners need to understand and respect each other's communication requirements. In a PPP, ensuring full transparency and yet enabling collaborators to keep some competitive advantage from privileged knowledge is a recurring challenge. Public sector parties are not always comfortable with this aspect of deal-making, and may wish to postpone discussions until more trust and understanding have been established. Experience suggests, however, that it is better to agree on the fundamentals of commercial rights and transparency before investing a lot of time and money in other aspects of the PPP.

The Advantages from this Partnership are as Follows

1. After involvement of private sector, On-time delivery of inputs, seeds, pesticides to the farmers.
2. Integration of resources of both sectors.
3. Creation of added value in the product.
4. Providing better public services.
5. Creation of better marketing facilities for the farmers
6. Supplementing limited public sector capacities.
7. Shared risk & responsibilities, so more effectiveness.
8. Benefits to small-scale, resource-poor and marginal farmers.

Conclusion

From the above article it is concluded that the usefulness is by no means limited to agricultural development, but PPPs can make a major contribution in agriculture sector. PPPs are not automatically the right choice to solve every challenge in agriculture. But in recent years there has been a trend towards privatization of government extension services. For that reason, partnership of public and the private sectors are made. The public sector must take earnest efforts to organize farmers and motivate and direct them so that they can demand appropriate and better extension services from the private sector also. There is also a need for transparency and trust between partners. After all collective action is needed for fulfilling the needs of resource poor farmers and food-insecure consumers as most of the people of the country are poor.

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