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Bionomics and Management of Water Lily Aphid *Rhopalosiphum nymphaeae* L. in Makhana *Euryale ferox* Salisb

Article ID: 40600

V. K. Padala[1], Ramya N[2]
[1]ICAR-RCER, Research Centre for Makhana, Darbhanga.
[2]Indian Agricultural Research Institute, New Delhi.

Introduction

Aphids are major pests of many economically important crops causes severe damage to crops. Apart from sucking the cell sap from the plant cells, they produce honeydew lead to development of sooty mould, which hampers the photosynthesis process. Besides this they also act as vectors for plant viruses which in turn lead to heavy yield loss. In the aquatic crop Makhana, *Euryale ferox* Salisb, the aphid, *Rhopalosiphum nymphaeae* (Hemiptera: Aphididae) is the major aphid species widely distributed throughout its growing areas and pose severe threat to Makhana in early stages of crop growing period. Due to its rapid population growth by asexual reproduction and increased resistance to insecticides, it is difficult to control with insecticides alone. Few integrated control strategies should fallow for effective management of aphids in Makhana.

Biology

Nymphs and adults are brownish or more or less shiny reddish-brown to dark olive aphids which colonise aquatic plants of several families. Wingless form body length is 1.6-2.6 mm. Siphunculi over twice length of cauda, very smooth, and distinctly clavate in apical half which is dusky compared with the pale basal half. Six antennal Segment.

Host Range

It has a broad host range, damage due to this species recorded from 45 plant families. This aphid mainly found on aquatic plants *Ipomea aquatic*, *Eichornia crassipes, Nymphodes cristatum. Marsilea* sp*., Hydrilla* sp*., Vallisneria* sp*. Polygonum* sp*. and Pistia* sp*.* The aphid infestation on Makhana first observed by Sarasati and her coworkers in 1990. It is a major pest observed during the nursery stage and early transplanted seedlings of Makhana. The aphid population on Makhana starts from last week of December and continued up to last week of March. The highest aphid population observed in last week of February. An adult female produces 2-6 youngones/day parthenogenetically and continued up to 10-12 days. In its life, it undergoes four nymphal instars before attaining adult stage. Newly emerged adult starts reproduction within 2 to 15 hrs.

Nature of Damage and Symptoms

Nymphs and adults suck the cell sap from upper surface tender leaves leads to leaf yellowing, etiolation and fast decay. In severe case of infestation tender seedling may die.

Fig. 1 Makhana leaf fully covered with Aphids and its exuviae

Favorable Conditions

Aphid population is influenced by several weather factors such as temperature, wind, relative humidity etc. Higher temperature and intermittent rains reduce the aphid population and cloudy weather congenial for population buildup.

Integrated Management of Aphid

1. In Makhana crop, number of natural enemies such as Coccinellid predators and parasitoids suppress the aphid population naturally. Hence, conservation of natural enemies in the field is very essential.
2. Many insecticides available in the market not safer to natural enemies, one should only opt for insecticides, when there is a smaller number of natural enemies in the field which fail to control increasing aphid population.
3. As preventive measure, seed treatment with Imidacloprid 70 WS @ 5 g/kg seed or root dipping in Imidacloprid 70 WS @ 5 g/Lt of water for half an hour at the time of transplanting should be fallowed.
4. If any aphid population observed after transplanting foliar spray with NSKE @ 0.5 per cent or Acetamaprid 20 SP@ 0.5gm/ Lt of water.

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Pre-Breeding A Tool for Crop Improvement

Article ID: 40601

Vengatesh M[1]
[1]Assistant Professor, Department of Plant Breeding and Genetics, Jaya Agricultural College, Vyasapuram, Tamil Nadu.

Plant breeding is the science driven creative process of developing new plant varieties that goes by various names including cultivar development, crop improvement, and seed improvement. Breeding involves the creation of multi-generation genetically diverse populations on which human selection is practiced to create adapted plants with new combinations of specific desirable traits. The selection process is driven by biological assessment in relevant target environments and knowledge of genes and genomes. Progress is assessed based on gain under selection, which is a function of genetic variation, selection intensity, and time.

What is Pre-Breeding in Plant Breeding?

Pre-breeding refers to all activities designed to identify desirable characteristics and/or genes from unadapted materials that cannot be used directly in breeding populations and to transfer these traits to an intermediate set of materials that breeders can use further in producing new varieties for farmers. Rick (1984) used the term pre-breeding or developmental breeding to describe the same activity. Thus "genetic enhancement" or "pre-breeding" refers to the transfer or introgression of genes or gene combinations from un-adapted sources such as landraces, wild species of crops and semi-wild relatives into breeding materials. It is an emerging concept emphasizing the use of plant genetic resources.

Importance of Pre-Breeding

Pre-breeding aims to reduce genetic uniformity in crops through the use of a wider pool of genetic material to increase yield, resistance to pests and diseases, and other quality traits. It also aims at base broadening which is achieved by either identification of genes that control traits of interest or moving these genes from un-adapted germplasm to adapted background. It plays an important role through genetically improving the yield performance, enhancement of agronomic, physiological and biotic stress tolerance in the germplasm. Germplasm enhancement should be regarded as a long-term activity, because exotic /wild germplasm seldom has immediate use without selection for local adaptation and enhanced yield potential. Thus, these programmes are independent of local crop genetic base until they become sources of parental material in normal breeding pool. Lack of pre-breeding programme is the most limiting factor for using landraces and crops wild relatives.

Differences Between Pre-Breeding and Traditional Breeding

Sr. No.	Pre breeding	Traditional Breeding
1	Pre-breeding is also known as genetic Enhancement.	Traditional breeding is also known as sustainable plant breeding.
2	It leads to genetic enhancement of germplasm.	It leads to development of productive cultivars/hybrids.
3	It leads to value addition.	It does not lead to value addition.
4	It leads to broadening the genetic base of the population.	It leads to development of improved cultivars with narrow genetic base.
5	The chief breeding method is backcross method.	All breeding methods such as introduction, selection, hybridization and mutation are used.
6	The end products are improved germplasm line.	The end product is cultivar or hybrid.
7	The end product is used as parent for developing improved cultivar, hybrid.	The end product is used for commercial cultivation.

8	It involves adapted and non-adapted genotypes in crossing programme	It includes only adapted genotype
9	It is a long-term breeding programme.	It is a short- or medium-term breeding programme.
10	It is taken up by public sector plant breeding organizations.	It is taken up by both public and private sector organizations.

Linking Gene Banks with Plant Breeders

Genebanks are repositories of genetic diversity of cultivated as well as their wild relatives and other wild species. The ultimate role of genebanks is to ensure the long-term availability of crop germplasm to sustain agricultural production, by providing pre-breeder and breeder with new genetic diversity that adds value to the future varieties. Pre-breeding helps in building a bridge that brings together the people who understand the scope of germplasm collections (gene bank managers) with those who introduce new traits into their varieties (plant breeders).

Pre-breeding acts as a link between plant genetic resources PGR (gene bank managers) and breeding (plant breeders). Plant breeders and gene bank managers must find ways to make it easier to effectively use germplasm from genebanks to produce new varieties with the traits the world needs.

Aims of Pre-Breeding Programs

1. Enhancement of genetic variability in the germplasm for its further use in regular breeding programme.
2. To reset the genetic diversity of crops by reintroducing genetic variability left behind.
3. To use genetic diversity that was not previously accessible due to genetic in-compatibilities or non-overlapping geographic range.
4. Gene banks mainly focused on the conservation aspects of Plant Genetic Resources and there is urgent need for active engagement with all stakeholders to enhance their utilization.

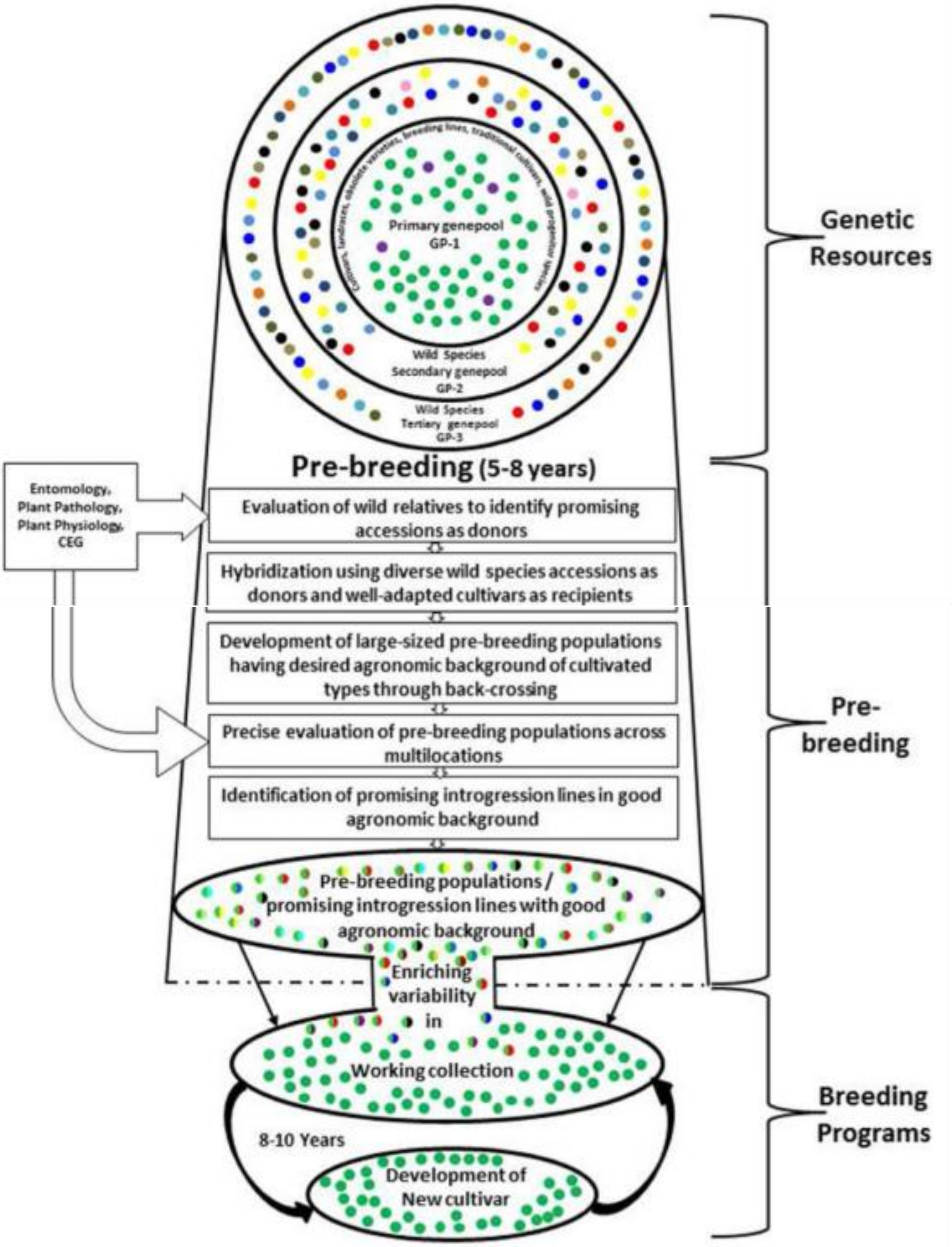
Major Activities of Pre-Breeding

1. Characterization of unadapted population and Identification of desirable traits / genes
2. Identification new traits from other sources
3. Creation of new parent population for transferring these traits into well-adapted lines
4. Creation of novel traits through mutation
5. Creation of polyploidy for new genetic variation
6. Development of new biotechnological and molecular techniques.

Planning for a Pre-Breeding Programme

When planning to utilize the unadapted germplasm or exotic parents for germplasm enhancement *via* pre breeding, the order of preference should be: Improved cultivars and breeding lines, Landraces or older cultivars, Closely related specie and More distantly related species and genera.

Procedure of Pre-Breeding



Examples of Pre-Breeding Projects (Source: https://www.cwrdiversity.org/)

The Project's pre-breeding work with durum wheat (Triticum durum) is being carried out by a team consisting of the University of Nottingham, the International Maize and Wheat Improvement Center (CIMMYT), the International Center for Agricultural Research in the Dry Areas (ICARDA), and the Directorate of Wheat Research in India. The durum wheat project is expected to take place between 2014 and 2018.

The objective of this pre-breeding work is to transfer genetic traits from wild wheat species that have already been introduced into hexaploid wheat into durum wheat, with the goal of developing superior, high-yield durum varieties that are well adapted to the changing environment. This pre-breeding work will focus on ten of the wild relatives of wheat: *Triticum urartu, Triticum timopheevii, Aegilops speltoides, Aegilops mutica, Aegilops mutica, Aegilops caudate, Secale cereal, Thinopyrum elongatum, Thinopyrum bessarabicum, Thynopyrum intermedium, and Thinopyrum ponticum.* The durum wheat lines developed through this work will be evaluated for a wide range of traits including disease resistance, yield potential, heat tolerance, and drought tolerance.

Conclusion

The process of pre-breeding identifies a useful character in unadapted materials, 'captures' it's genetic diversity, and incorporates those genes into a usable form employing different techniques. Pre breeding is a way to shorten the duration of Varietal improvement.

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Entomopathogenic Bacteria, Protozoa and Rickettsia Strains with Target Pests and Available Commercial Products

Article ID: 40602

M. N. Rudra Gouda[1]
[1]Ph.D. scholar, division of entomology, Indian agricultural research institute (IARI), New Delhi.

Introduction

Entomopathogens are pathogenic microorganisms for arthropods such as insects, mites, and parasites. Multiple species of naturally occurring bacteria, fungi, nematodes, and viruses infect numerous arthropod parasites and play a crucial role in their control. Some entomopathogens are mass-produced and sold commercially in vitro (bacteria, fungi, and nematodes) or in vivo (nematodes and viruses). In some instances, they are also produced locally on a limited scale for non-commercial purposes. Microbial control refers to the use of entomopathogens as biopesticides in pest management, which can be an integral component of integrated pest management (IPM) against multiple pests.

Some entomopathogens have been or are being used in a classical microbial control strategy in which exotic microorganisms are imported and dispersed for the long-term management of invasive pests. The discharge of exotic microorganisms is strictly regulated and conducted only after extensive and rigorous testing by government agencies. In contrast, commercially available entomopathogens are typically applied as biopesticides via inundative methods and are utilised by farmers, government agencies, and householders. Understanding the mode of action, ecological adaptations, host range, and dynamics of pathogen-arthropod-plant interactions is crucial for the effective use of entomopathogen-based biopesticides in agriculture, horticulture, orchard, landscape, and urban environments.

Entomopathogenic Bacteria

Bacterial Strain	Commercial product	Dose	Target pest	Country of origin
Paenibacillus popilliae	Milky Spore (powder)	5 kg / acr	Japanese beetle grubs	USA
B. sphaericus	Larvicide, Spherifix, LarvX	One tablet / 50 lit water	Mosquitoes	-
Bacillus thuringiensis subsp *thuringiensis*	Muscabac	750 – 1000 g or ml / ha	Dimond Back Moth, Flies	Sweden
B.t. subsp. *aizawai*	Certan, Agree & Xentari	750 – 1000 g or ml / ha	Lepidopteran larvae	-
B.t. subsp. sotto	-	-	Lepidopteran larvae	Japan
B.t. subsp. berliner	-	-	Lepidopteran larvae	Germany
B.t. subsp. entomocidus	-	-	Lepidopteran larvae	-
B.t. subsp. galleriae	Spicturin	750 – 1000 g or ml / ha	Lepidopteran larvae	-
B.t. subsp. sandiago	M – Trak & Novodor	750 – 1000 g or ml / acr	Beetle grubs	-
B.t. subsp. israelensis	Culinex Tab plus, Vectobac, Thurimose	One tablet / 50 lit water	Mosquitoes, Flies	Israel
B.t. subsp. kurstaki	Dipel (WP, ES), Thuricide, Biobit, Halt, Biolep and Bioasp	750 – 1000 g or ml / ha	Lepidopteran larvae	Germany, India

B.t. subsp. tenebrionis	CX- 2316, M-one, Di Terra, Novodor	750 – 1000 g or ml / acr	Beetle grubs	Europe
Clostridium bifermentans	-	-	Mosquitoes	-
Saccharopolyspora spinosa	-	-	Two-spotted spider mites	-
Streptomyces avermitilis	-	-	Colorado potato beetle	-
Pseudomonas alcaligenes	-	-	Locusts, grasshoppers	-
Serratia entomophila (626)	Invade	1000 ml / ha	New Zealand grass grub	New Zealand

Entomopathogenic Protozoa

Strain	Trade name	Dose	Target pest	Country of origin
Nosema locustae	Nolo bait, Noloc Semaspore Grasshopper Attack		*Locusta migratoria* & *Anabrus simplex*	USA
Farinocystis tribolii	-	-	Red flour beetle	-
Vairimorpha necatrix	-	-	Lepidopteran larva	-
Nosema heliothidis	-	-	American bollworm	-
Mattesia grandis	-	-	Cotton bollworms	-
Nosema melolontha	-	-	Chaffer beetles	-
Gregarina crassa	-	-	Red flour beetle	-
Gregarina cuneata	-	-	Red flour beetle	-
Gregarina minuta	-	-	Red flour beetle	-
Steinlna obconica	-	-	Red flour beetle	-
Hirmocystis oxeata	-	-	Red flour beetle	-
Hirmocystis triboli	-	-	Red flour beetle	-
Paranosema whitei	-	-	Red flour beetle	-

Entomopathogenic Rickettsia

Strain	Trade name	Dose	Target pest	Country of origin
Rickettsia melophagi	-	-	*Melophagus ovinus*, sheep-ked	-
Rickettsia prowazeki	-	-	*Pediculus humanus*, body louse	-
Rickettsia linognathi	-	-	*Linognathus stenopsis* goat lose	-
Rickettsia lectularia	-	-	*Cimex lectularius*, bedbug	-
Rickettsia trichodectae	-	-	*Trkchodectes pilosus*, horse louse	-
Rickettsiella schitoscera	-	-	*Schitoscera gregaria*	-
Rickettsiella grylli	-	-	Cricket	-
Rickettsia popilliae	-	-	Japanese bettle	-
Rickettsia melolontha	-	-	Scarabid bettle	-

Conclusion

Entomopathogens can be important tools in IPM strategies in both organic and conventional production systems. Depending on the crop, pest, and environmental conditions, entomopathogens can be used alone or in combination with chemical, botanical pesticides or other entomopathogens.

Cryopreservation- New Way for Preservation

Article ID: 40603

Neha Goswami[1]

[1]Department of Extension Education and Communication Management, College of Community and Applied Sciences, Maharana Pratap University of Agriculture and Technology, Udaipur.

Abstract

Cryopreservation is a process that preserves organelles, cells, tissues, or any other biological constructs by cooling the samples to very low temperatures. The responses of living cells to ice formation are of theoretical interest and practical relevance. Stem cells and other viable tissues, which have great potential for use in basic research as well as for many medical applications, cannot be stored with simple cooling or freezing for a long time because ice crystal formation, osmotic shock, and membrane damage during freezing and thawing will cause cell death. The successful cryopreservation of cells and tissues has been gradually increasing in recent years, with the use of cryoprotective agents and temperature control equipments. Continuous understanding of the physical and chemical properties that occur in the freezing and thawing cycle will be necessary for the successful cryopreservation of cells or tissues and their clinical applications.

Keywords: Cryopreservation, Cryoprotective agents, Environment, Environment conservation, Nature etc.

Introduction

Cryopreservation is the method of keeping the live cells, tissues and other biological samples in a deep freeze at subzero temperatures for the storage or preservation. The sample is commonly kept at −196°C. At such low temperatures, all the biological activities of the cells stop and the cell dies. Cryopreservation helps the cells to survive freezing and thawing. The ice formation inside the cells can break the cell membrane. This can be prevented by regulating the freezing rate and carefully choosing the freezing medium. Dry Ice and liquid nitrogen are generally used in this method.

The word **"cryo"** comes from the Greek word **"kayos"** meaning "frost". It means preservation in a "frozen state". It is the process of cooling and storing cells, tissues, or organs at very low temperatures to maintain their viability. Cryopreservation is a technique in which low temperature is used to preserve the living cells and tissue. In this technique, tissues can be preserved for a very long time. The science that deals with cryopreservation is known as "cryobiology". It can be done over the following temperature:

1. Solid carbon dioxide (at -79^{o}C)
2. Low-temperature deep freezer (at -80^{o}C)
3. In vapor phase nitrogen (at -150^{o}C)
4. In liquid nitrogen (at -196^{o}C).

Vitrification

The word "vitrification" comes from the Latin term for glass, vitrum. Vitrification is a flash-freezing (ultra-rapid cooling) process that helps to prevent the formation of ice crystals and helps prevent cryopreservation damage. Vitrification is an alternative approach to cryopreservation that enables hydrated living cells to be cooled to cryogenic temperatures in the absence of ice. In the context of freezing eggs and embryos, vitrification is the process of freezing so rapidly that that the water molecules don't have time to form ice crystals, and instead instantaneously solidify into a glass-like structure.

Cryopreservation Steps

The complete procedure steps involved in preserving the obtained biological samples are as follows:

1. Harvesting or Selection of material– Few important criteria should be followed while selecting the biological materials such as – volume, density, pH, morphology, and without any damage.

2. Addition of cryo-protectant – Cryoprotective agents such as glycerol, FBS, salts, sugars, glycols are added to the samples as it reduces the freezing point of the medium and also allow slower cooling rate, which reduces the risk of crystallization.

3. Freezing – Different methods of freezing are applied in this method of cryopreservation to protect cells from damage and cell death by their exposure to the warm solutions of cryoprotective agents.

4. Storage in liquid nitrogen– The cryopreserved samples are stored in extreme cold or -80°C in a freezer for at least 5 to 24 hours before transferring it to the storage vessels.

5. Thawing- The process of warming the biological samples in order to control the rate of cooling and prevent the cell damage caused by the crystallization.

Benefits of Cryopreservation

There are many benefits of cryopreservation technique. These include:
1. Fertility treatments.
2. Minimal space and labour required.
3. Safety from genetic contamination.
4. Safeguards genetic integrity of valuable stains.
5. Safeguards the germ-plasm of endangered species.
6. Biological samples can be preserved for a longer period of time.
7. Protects the samples from disease and microbial contamination.
8. Prevents genetic drift by cryopreservation of gametes, embryos, etc.
9. In vitro conservation, especially by cryopreservation in liquid nitrogen at a temperature of -196 Celsius, is particularly useful for conserving vegetation.

Applications of Cryopreservation

Cryopreservation is a long-term storage technique, which is mainly used for preserving and maintaining viability of the biological samples for a longer duration. This method of preservation is widely used in different sectors including cryosurgery, molecular biology, ecology, food science, plant physiology, and in many medical applications. Other applications of cryopreservation process are:
1. Conservation of endangered plant species.
2. Biodiversity conservation.
3. Storage of rare germplasm.
4. Blood transfusion.
5. In vitro fertilization.
6. Organ transplantation.
7. Artificial insemination.
8. Freezing of cell cultures.
9. Seed Bank.
10. Gene Bank.

Environment Conservation Through Cryopreservation

The trends observed in the loss of plant biodiversity over the last 100 years have been a matter of great concern. Conversion of primary vegetation to agriculture, climate change combined with habitat loss and fragmentation are the main key factors affecting biodiversity and to cause species to become extinct. The situation today is still very alarming, despite the efforts made to conserve plant diversity. It has been shown that increase in global temperature will increase the species turnover rate and decrease the mean stable area of species in all biomes. Changes in mean climate variables and greater risks of extreme weather, including prolonged drought and storms, are events that biomes will have to adapt to. Climate change has also known to be related to the observed northward and uphill distribution shifts of many European plant species. Changing climate will cause a myriad of changes, and therefore, different kinds of conservation strategies related to in-situ or *ex-situ* maintenance of plant populations need to be applied. From these, in-situ conservation, preservation of threatened plant population in the original environment is no doubt of highest priority. However, in-situ conservation is suitable mainly for the species and populations that can be preserved in the original environment of the species, e.g. in protected areas in natural reserves and conservation corridors. In a situation, where in-situ conservation is not possible, *ex-situ* conservation i.e. conservation outside the original environment—is the method of choice. Furthermore, *ex-situ* conservation is applicable as an additional conservation method to in situ method working as a backup collection for the most vulnerable material. For example, clonal field repositories, botanical gardens, seed banks and in-vitro collections are widely applied for both economically important and endangered plant species. Thus, *ex-situ* conservation is applied as an additional measure to supplement in situ conservation.

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Role of Biofertilizer in Agriculture

Article ID: 40604

S. S Kinge[1], A. J. Rathod[2]
[1]Ph.D.(scholar) Department of Agronomy, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth Dapoli.
[2]Ph.D.(scholar) Department of Agronomy, PGI, Mahatma Phule Krishi Vidyapeeth Rahuri.

Introduction

Biofertilizer are microorganisms that help plants to grow by increasing the quantity of nutrients. Biofertilizer are defined as preparations containing living cells or latent cells of efficient strains of microorganisms that help crop plants for the uptake of nutrients by their interactions in the rhizosphere. Bio - living and Fertilizer-things that nourished the crops. Biofertilizer is a substance or product which contain selective strains of microorganisms which can contribute nutrients to plants through microbial activity.

Need of Biofertilizers

1. Bio-fertilizers offers eco-friendly technology.
2. They improve soil fertility and increase crop yield up to 10-40%.
3. They improve pH and other properties of soil (Biological, Physical & Chemical).
4. They produce growth promoting substances (IAA, amino acids, vitamins).
5. It results in reduced cost of fertilization.

Importance Of Biofertilizer

1. Increasing Harvest Yields:

a. Average increase crop yields by 20 to 30 percent.
b. Algae-based fertilizers have improved yields in rice at rates ranging between 10 and 45%.

2. Improving Soil structure: Use of microbial bio fertilizers improves the soil structure by influencing the aggregation of the soil particles

3. Better water relation:

a. Arbuscular mycorrhizal colonization induces drought tolerance in plants by following points.
b. Improving leaf water and turgor potential,
c. Maintaining stomatal functioning and transpiration
d. Increasing root length and development.

Lowering Production Costs

1. Made from easily obtained organic materials such as rice husks, soil, bamboo, and vegetables etc.
2. Reduce the input expenses by replacing the cost of chemical fertilizers.

Fortifying the Soil

1. Aquatic cyanobacteria provide natural growth hormone, protein, vitamins and minerals to the soil.
2. Azotobacter infuse the soil with antibiotic pesticide and inhibit the spread of soil-borne diseases like pythium and phytophthora.

Improving Sustainability

1. Biofertilizer strengthen the soil profile,
2. leave water sources untainted and
3. Edify plant growth without detrimental side-effects.

How does Biofertilizer Work?

1. Fix atmospheric nitrogen in the soil and root nodules of legume crop ad make it available to the plants.
2. Solubilise the insoluble forms of phosphates like tricalcium, iron and aluminium phosphate into available forms.

3. Produce hormones and anti-metabolites which promote root growth.
4. They scavenge phosphate from soil layers.
5. Decompose organic matter and help in soil mineralization.

The Major Microorganisms Used as Biofertilizer are

Nitrogen fixing Biofertilizers:

a. Rhizobium

i. A soil habitat bacterium able to colonize the legume roots
ii. Fixes atmospheric elemental nitrogen symbiotically into plant usable form.
iii. Fixes 50-100 kg/ha/year of nitrogen, most useful in concern with amount of N_2 fixed. It is especially important for legumes and oilseeds.

b. Cyanobacteria: Both free-living as well as symbiotic cyanobacteria (blue green algae) have been harnessed in rice cultivation.

i. The benefits due to algalization could be to the extent of 20-30 kg/ha.
ii. Add growth-promoting substances & vitamin B12
iii. Improve the soil's aeration, water holding capacity and add to bio mass when decomposed after life cycle.

c. Azospirillium:

i. Proliferates under both anaerobic and aerobic condition.
ii. Nitrogen fixing ability of 20-40 kg/ha
iii. PGRS production (IAA), disease resistance and drought tolerance are some of the additional benefits.

d. Azolla:

i. A free-floating water fern used as Biofertilizer for wetland rice.
ii. Fixes atmospheric nitrogen in association with nitrogen fixing blue green algae Anabaena azollae.
iii. Known to contribute 40-60 kg N/haj per rice crop.

e. Azotobacter:

i. A free-living bacterium mostly found in neutral to alkaline soils.
ii. Fixes the atmospheric nitrogen by converting into ammonia.
iii. Produces abundant slime which helps in soil aggregation.
iv. Fix biologically active PGRS like IAA and gibberellins.

Phosphate solubilizing Biofertilizer:

a. Group of beneficial bacteria capable of hydrolysing organic and inorganic phosphorus from insoluble compounds
b. Pseudomonas, Bacillus and Rhizobium are among the most powerful
c. Seed inoculation of PSB- 30 kg P_2O, /ha.

Phosphate mobilizing Biofertilizer (Mycorrhiza):

a. A symbiotic generally mutualistic association between a fungus and the roots of a vascular plant.
b. The fungus colonizes the host plant's roots, either intracellularly or extracellularly.
c. This association provides the fungus with access to carbohydrates
d. In return, the plant gains the benefits of the mycelium's higher absorptive capacity for water and mineral
e. Plant roots alone may be incapable of taking up phosphate ions that are demineralized in soils with a basic pH
f. The mycelium of the mycorrhizal fungus can make them available to the plants they colonize.

Silicate and Zinc solubilizing Biofertilizer:

a. Microorganisms are capable of degrading silicates and aluminum silicates
b. Bacillus sp can be used as bio-fertilizer for zinc or aluminum silicates because these organisms solubilize the zinc present in the soil and make it available to the plants.
c. Plant Growth Promoting Rhizobacteria (PGPR)
d. Species of Pseudomonas and Bacillus can produce phytohormones or growth promoters.

e. They produce include indole-acetic acid, cytokinins, gibberellins and inhibitors of ethylene production.

Role of Biofertilizers in Soil Fertility and Agriculture

1. They supplement chemical fertilizers for meeting the integrated nutrient demand of the crops.

2. They can add 20-200 kg N/ha year (eg. Rhizobium sp 50-100 kg N/ha year; Azospirillum, Azotobacter: 20-40 kg N/ha /yr; Azolla: 40-80 kg N/ha; BGA :20-30 kg N/ha) under optimum soil conditions and thereby increases 15-25 percent of total crop yield.

3. They can at best minimize the use of chemical fertilizers not exceeding 40-50 kg N/ha under ideal agronomic and pest-free conditions.

4. Application of Biofertilizers results in increased mineral and water uptake, root development, vegetative growth and nitrogen fixation.

5. Some Biofertilizers (eg, Rhizobium BGA, Azotobacter sp) stimulate production of growth promoting substance like vitamin- B complex, Indole acetic acid (IAA) and Gibberellic acids etc.

6. Phosphate mobilizing or phosphorus solubilizing Biofertilizers / microorganisms (bacteria, fungi, mycorrhiza etc.) converts insoluble soil phosphate into soluble forms by secreting several organic acids and under optimum conditions they can solubilize / mobilize about 30-50 kg P205/ha due to which crop yield may increase by 10 to 20%.

7. Mycorrhiza or VA-mycorrhiza (VAM fungi) when used as Biofertilizers enhance uptake of P, Zn, S and water, leading to uniform crop growth and increased yield and also enhance resistance to root diseases and improve hardiness of transplant stock. They liberate growth promoting substances and vitamins and help to maintain soil fertility.

8. They act as antagonists and suppress the incidence of soil borne plant pathogens and thus, help in the bio-control of diseases.

9. Nitrogen fixing, phosphate mobilizing and cellulolytic microorganisms in bio- fertilizer enhance the availability of plant nutrients in the soil and thus, sustain the agricultural production and farming system.

10. They are cheaper, pollution free and renewable energy sources.

11. They improve physical properties of soil, soil tilth and soil health in general.

12. They improve soil fertility and soil productivity.

13. Blue green algae like Nosto, Anabaena, and Scytonema are often employed in the reclamation of alkaline soils.

14. Bio-inoculants containing cellulolytic and lignolytic microorganisms enhance the degradation/ decomposition of organic matter in soil, as well as enhance the rate of decomposition in compost pit.

15. BGA plays a vital role in the nitrogen economy of rice fields in tropical regions. Azotobacter inoculants when applied to many non-leguminous crop plants, promote seed germination and initial vigor of plants by producing growth promoting substances.

16. Azolla-Anabaena grows profusely as a floating plant in the flooded rice fields and can fix 100-150 kg N/ha /year in approximately 40-60 tons of biomass produced, Plays important role in the recycling of plant nutrients.

Conclusion

Bio-fertilizers being essential components of nutrient management can play pivotal role in maintaining soil fertility but they cannot totally replace chemical fertilizers. The changing scenario of agricultural practices and environmental hazards associated with chemical fertilizers demand a more significant role of biofertilizers in coming years.

1. Biofertilizer have great role in increasing the crop production
2. They improve the soil health status and provide different growth promoting hormones and phytohormones to the plant
3. Also do not leave the residual effects like that of the chemical fertilizers.

4. Hence the use of Biofertilizer could be the proper option for sustainable agriculture.
5. From the foregoing discussion it can be concluded that biofertilizers.
6. Significantly reduce the chemical fertilizer requirements (especially N and P).
7. Improve soil fertility and productivities
8. Ensure food and nutritional security.

Aphid: As Vector of Plant Diseases and their Management

Article ID: 40605

Swati Lonagre[1]

[1](PhD Scholar) Post Graduate Institute Dr. PDKV Akola.

Abstract

The majority of viruses infecting plants are spread by insects, and aphids are the most common group of virus vectors or carriers. All potyviruses (the largest group of plant viruses) are transmitted by aphids. Aphids are sap-sucking insects and have piercing, sucking mouthparts. Their mouthparts include a needle-like stylet that allows the aphid to access and feed on the contents of plant cells. During feeding, aphids simultaneously ingest sap contents and inject saliva, which can contain viruses if the aphid has previously fed on an infected plant. The structure of aphid mouthparts, their searching behaviour for host plants, the range of available host plants and high reproductive rates contribute to the efficiency of aphids to act as virus carriers.

Introduction

The majority of aphid vectors belong to the subfamily aphidinae (Order: Homoptera) (Blackman and Eastop, 2000). Aphid vectors are also found in nine other subfamilies, but they account for only a very small proportion of those that are known to transmit viruses. A number of unique features contribute to the success of aphids as vectors of plant viruses. These include: (i) a polyphagous nature for some aphid species (e.g. *Myzus persicae*) that allows them to feed on a wide range of plant hosts, a property important for the dissemination of viruses that infect a large number of plant species; (ii) the ability to undergo parthenogenetic reproduction, thus facilitating the rapid production of large quantities of offspring; and (iii) the possession of a needle-like stylet capable of piercing plant cell walls and delivering viruses into a host cell . Feeding behaviour and host plant selection by an aphid will affect its potential as a vector. The extent to which these factors influence virus transmission (positively or negatively) will depend on the specific virus and its mechanism of transmission. From the standpoint of applied research, understanding the spread and control of viral diseases requires an understanding of the vector and its behaviour; vector transmission is paramount to epidemiology.

In this chapter we provide a brief overview of the viruses that are transmitted by aphids and discuss concepts and mechanisms underlying transmission. Most plant viruses are the result of a coevolution of virus and vector. A greater understanding of mechanisms behind the transmission process will be important in determining how these forces have played a role in shaping the evolution of plant viruses.

Virus Transmission Step Wise Process

Acquisition: uptake of virus from an infected source
Retention: stable retention of acquired various at requisite sites within the vector
Inoculation: the release off bound or retained various and their delivery to a site of infection.
Transmission of a virus by insects is a specific biological process. A particular virus is transmitted by one carrier group only—for example aphids or whiteflies, not both.

Mode of Virus Transmission

The fundamental distinction in transmission- ingested virions is circulative or non- circulative in the vector.
Focuses on the duration
Site of retention of virions
Route of movement within the aphid.

Circulative viruses: are taken up into cells, cross multiple membrane barriers, are transported within the vector haemolymph and ultimately exit the aphid in its saliva.

Non-circulative viruses- more superficial and transient relationship with the vector and only associated with the mouthparts and foregut

Among the aphid-vectored plant viruses, a majority are transmitted in a non-circulative manner.

Depending on the length of time that an aphid remains viruliferous following feeding on an infected plant.

Non-persistent: if aphid moults, virus is lost (does not persist)

Semi persistent: Acquisition within minutes, but the efficiency increases with prolonged feeding.

Non-persistent	Semi-persistent	Circulative
Acquisition period is very low (from second to minutes)	Acquisition period is more (from minutes to hours)	Acquisition period is more (from minutes to hours)
No latent period	No latent period	Latent period is high (hours -days-weeks)
Inoculation period is low (from seconds to minutes)	Inoculation period is more (from minutes to hours)	Inoculation period is more (from minutes to hours)
Persistent: min-<4 hra	Persistent :1-100 hrs	Persistent > 100 hrs
Longer feeding less transmission	Longer feeding longer transmission	Longer feeding longer transmission
Ability to transmit is lost between molts	Ability to transmit is lost between molts	Ability to transmit is retained between molts
Mechanically transmissible	Some are Mechanically transmissible	Mechanically not transmissible
Ex. Mosaic type diseases	Ex. Mosaic & yellow type diseases	Ex yellows type and leaf rolling diseases

Important Aphid Transmitted Viral Diseases

Sr.no	Name of diseases	Vector	Loss
1	Papaya mosaic 	*Aphis craccivora*	30-40
2	Cucumber mosaic 	*Myzus persicae*	50-60
3	Potato leaf curl roll 	*Myzus persicae*	38-42
4	Banana bunchy top 	*Pentalonia nigronervosa*	70-100
5	Banana mosaic	*Pentalonia nigronervosa*	20-30

			
6	Cardamom foorkey diseases 	*Pentalonia nigronervosa*	28-37
7	Groundnut rosette 	*Aphis craccivora*	39-41
8	Sugarcane mosaic 	*Rhopalosiphum maidis*	20-30
9	Green peach aphid	*Myzus persicae*	30-40

Monitoring

Check your plants regularly for aphids—at least twice a week when plants are growing rapidly in order to catch infestations early, so you can knock or hose them off or prune them out. Many species of aphids cause the greatest damage in late spring when temperatures are warm but not hot (65°-80°F). For aphids that cause leaves to curl, once aphid numbers are high and they have begun to distort leaves, it's often difficult to control these pests, because the curled leaves shelter aphids from insecticides and natural enemies.

Biological Control

Many predators also feed on aphids. The most well-known are lady beetle adults and larvae, lacewing larvae, soldier beetles, and syrphid fly larvae.

Cultural Control

Before planting vegetables, check surrounding areas for sources of aphids and remove these sources. Some aphids build up on weeds such as sowthistle and mustards, moving onto related crop seedlings after they emerge. On the other hand, these aphid-infested weeds can sometimes provide an early source of aphid natural enemies. Always check transplants for aphids and remove them before planting.

Where aphid populations are localized on a few curled leaves or new shoots, the best control may be to prune out these areas and dispose of them. In large trees, some aphids thrive in the dense inner canopy; pruning out these areas can make the habitat less suitable.

High levels of nitrogen fertilizer favor aphid reproduction, so never use more nitrogen than necessary. Instead, use a less soluble form of nitrogen and apply it in small portions throughout the season rather than all at once. Slow-release fertilizers such as organic fertilizers or urea-based time-release formulations are best.

Because many vegetables are susceptible to serious aphid damage primarily during the seedling stage, reduce losses by growing seedlings under protective covers in the garden, in a greenhouse, or inside and then transplanting them when the seedlings are older and more tolerant of aphid feeding. Protective covers will also prevent transmission of aphid-borne viruses.

Silver-colored reflective mulches have been successfully used to reduce transmission of aphid-borne viruses in summer squash, melon, and other susceptible vegetables. These mulches repel invading aphid populations, reducing their numbers on seedlings and small plants. Another benefit is that yields of vegetables grown on reflective mulches are usually increased by the greater amount of solar energy reflecting onto leaves.

To put reflective mulch in your garden, remove all weeds and cover beds with mulch. Bury the edges with soil to hold them down. After the mulch is in place, cut or burn 3- to 4-inch diameter holes and plant several seeds or a single transplant in each one. In addition to repelling aphids, leafhoppers, and some other insects, the mulch will enhance crop growth and control weeds. When summertime temperatures get high, however, remove mulches to prevent overheating plants.

Ready-to-use reflective mulch products include silver-colored plastic sold in rolls. You can also make your own by spray-painting construction paper, landscape fabric, or clear plastic. If you use plastic mulches, you will need to use drip irrigation underneath. Landscape fabric and most paper mulches will allow water to flow through.

Another way to reduce aphid populations on sturdy plants is to knock off the insects with a strong spray of water. Most dislodged aphids won't be able to return to the plant, and their honeydew will be washed off as well. Using water sprays early in the day allows plants to dry off rapidly in the sun and be less susceptible to fungal diseases.

Chemical Control

When considering whether to apply insecticides for aphid control, remember that most larger plants can tolerate light to moderate levels of aphids with little damage. Larger aphid populations often rapidly decline due to biological control or when hot temperatures arrive. Often a forceful spray of water or water-soap solution, even on large street trees, when applied with appropriate equipment, will provide sufficient control.

If insecticides are needed, insecticidal soaps and oils are the best choices for most situations. Oils may include petroleum-based horticultural oils or plant-derived oils such as neem or canola oil. These products kill primarily by smothering the aphid, so thorough coverage of infested foliage is required. Apply these materials with a high volume of water, usually a 1 to 2% oil solution in water, and target the underside of leaves as well as the top. Soaps, neem oil, and horticultural oil kill only aphids present on the day they are sprayed, so applications may need to be repeated. Although these materials can kill some natural enemies that are present on the plant and hit by the spray, they leave no toxic residue so they don't kill natural enemies that migrate in after the spray.

These and other insecticides with contact-only activity are generally ineffective in preventing damage from aphids such as the leaf curl plum aphid or the woolly ash aphid, which are protected by galls or distorted foliage. Also, don't use soaps or oils on water-stressed plants or when the temperature exceeds 90°F. These materials may be phytotoxic to some plants, so check labels and test the materials on a portion of the foliage several days before applying a full treatment.

Supreme- or superior-type oils will kill overwintering eggs of aphids on fruit trees if applied as a delayed-dormant application just as eggs are beginning to hatch in early spring. (On plums dormant applications right after leaves have fallen in early November are preferred.) These treatments won't give complete control of aphids and probably aren't justified for aphid control alone but will also control soft scale insects if they are a problem. Common aphid species controlled with these types of oils include the woolly apple aphid, green apple aphid, rosy apple aphid, mealy plum aphid, and black cherry aphid.

Many other insecticides are available to control aphids in the home garden and landscape, including foliar-applied formulations of malathion, permethrin, and acephate (nonfood crops only). While these materials may kill higher numbers of aphids than soaps and oils, their use should be limited, because they also kill the natural enemies that provide long-term control of aphids and other pests, and they are associated with bee kills and environmental problems. Repeated applications of these materials may also result in resistance to the material.

Insecticides such as oils and soaps are also safer to use when children and pets may be present. Formulations combining insecticidal soaps and pyrethrins may provide slightly more knockdown than soaps alone yet have fewer negative impacts on natural enemies than malathion, permethrin, and acephate, because pyrethrins break down very quickly.

Systemic insecticides are also available for aphid management, primarily for woody ornamentals. These materials, including imidacloprid, are very effective and are especially useful for serious infestations of aphids such as the woolly hackberry aphid, which is often not effectively controlled by biological control or less toxic insecticides. Imidacloprid can have negative impacts on predators, parasitoids, and pollinators, so its use should be avoided where soaps and oils will provide adequate control. To protect pollinators, don't apply imidacloprid or other systemic insecticides to plants in bloom or prior to bloom.

Home-use soil-applied imidacloprid products are often diluted with water in a bucket and poured around the base of the tree or plant. Professional applicators can use soil injectors, which provide better control with less runoff potential. Applications are usually made in spring when aphids first become apparent.

Conclusion

Aphid vector transmission has been selected for in a diversity of plant viruses. The mechanisms of transmission can be strikingly different, and there is no correlation with genome type, replication strategy or particle morphology. One of the forefronts in the field of virus–vector relationships is elucidating the fate of virions within the vector, e.g. identifying ligands to which virions bind, their paths of movement and (where relevant) tissue tropisms. Ligands may be individual protein receptors mediating virion uptake via endocytosis or may prove to be complex (or less well defined) surfaces such as components of the cuticular lining of the stylet and foregut, a matrix of carbohydrates, proteins and lipids. A relatively unexplored area of research in plant virology is that of early events of infection. Aphid vectors are responsible for positioning viruses at their sites of infection. Because salivation appears to play an essential role in the release of virions, an understanding of virus entry may ultimately require a better understanding of salivation. Just as there has been a coevolution of viruses with their aphid vectors, our knowledge of viruses will evolve with our insights into vector biology.

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Apiculture

Article ID: 40606

Swati Lonagre[1]
[1](PhD Scholar) Post Graduate Institute Dr. PDKV Akola.

Introduction

"Apiculture is the Scientific Method of Rearing Honeybees."

The word 'apiculture comes from the Latin word 'apis' meaning bee. So, apiculture or beekeeping is the care and management of honey bees for the production of honey and wax. In this method, bees are bred commercially in apiaries, an area where a lot of beehives can be placed. Usually, apiaries are set up in areas where there are sufficient bee pastures such as areas that have flowering plant. Honey bees are the best pollinating agents which help in increasing the yield of several crops. According to recent studies, the honey bee's venom contains a mixture of proteins which can potentially be used as a prophylactic to destroy HIV that causes AIDS in humans. Honey revolution just like white revolution would be a deterrent for current trends in large-scale emigration to the cities.

Different Species of Honey Bees

Characteristics of four well known species of honey bees:

1. Rock bee: *Apis dorsata:*

a. Nesting - Open nesting. Builds single large comb, attached to branches of trees or rocks.
b. Distribution in India- Found in plains as well as hills up to 1600 metres above sea level. Highly migratory.
c. Size - Biggest honey bee (16-18mm) Swarming/ Absconding - Strong tendency Temperament– Furious
d. Average honey yield per colony/year - 40 kg (wild bees; cannot be domesticated)
e. Method of honey extraction - By squeezing (unhygienic).


2. Little bee: *Apis florea:*

a. Nesting - Open nesting. Builds single small comb (size of palm of hand) fixed to branches of bushes.
b. Distribution in India- Found in plains up to 300 metres above sea level. Highly migratory.
c. Size - Smallest bee (9- 10mm)
d. Swarming/ Absconding - Strong tendency
e. Temperament– Mild
f. Average honey yield per colony/year -500 g (wild bees; cannot be domesticated)
g. Method of honey extraction - By squeezing (unhygienic).


3. Asian bee: *Apis cerana indica:*

a. Nesting - Cavity nesting. Builds many parallel combs in cavities of tree trunks, hollows of rocks, poles and other covered places.
b. Distribution in India- Found throughout the India
c. Size - Medium size (14-15mm)
d. Swarming/ Absconding - Strong tendency
e. Temperament– Mild
f. Average honey yield per colony/year - 5 kg (Hive bees; can be domesticated)
g. Method of honey extraction - By centrifugal honey extractor from the hived bees (Hygienic).


4. European bee: *Apis mellifera:*

a. Nesting - Cavity nesting and similar in habits to Apis cerana and builds parallel combs.
b. Distribution in India- Exotic bee to India. Introduced successfully in 1962. It has many subspecies (more than 23) throughout world.
c. Size - Medium size (14- 16mm)
d. Swarming/ Absconding - Only in African sub species
e. Temperament– Gentle except African sub species
f. Average honey yield per colony/year - 15 kg per hive bees; can bedomesticated)
g. Method of honey extraction - By centrifugal honey extractor from the hived bees (Hygienic).


5. Stingless honey bees: *Trigona irridipennis:*

a. In addition to honey bees of genus Apis, stingless honey bees also provide honey.
b. Stingless or dammar bees are of smallest size compared to other honey-yielding bees (less than 5 mm).
c. They belong to the family Apidae and subfamily Meliponinae.
d. It consists of two genera Melipona and Trigona.
e. These bees are also domesticated, but produce little amount of honey (100 gm). These are mainly reared for pollination purpose.

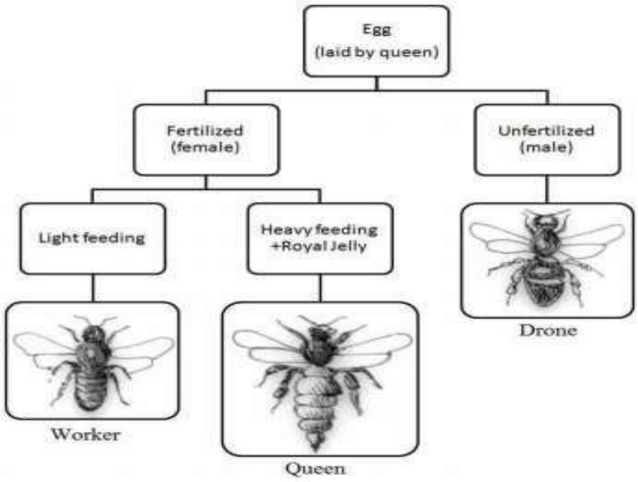
Colony Organization and Division of Labour

Honey bees are social insects and live in colonies. A normal colony, during active season is composed of 3 kinds of individuals: one queen, thousands of workers (10000 to 30000 or even more) and few hundreds of drones, which vary in size.

In addition, each colony has different developmental stages viz. eggs, larvae and pupae which are collectively known as brood.

Queen

1. Only one queen is found in a colony except under supersedure or swarming instinct.
2. She is the mother of the whole colony producing workers and drones and is the only perfectly developed female member of the colony.
3. The virgin queen mates with a number of drones (5-7) within 5-10 days of emergence in the air (not inside the hive) and spermatozoa are stored in spermatheca. Stored sperms are utilized to fertilize eggs throughout her life, till exhausted.
4. The queen lays both fertilized and unfertilized eggs. Fertilized eggs produce workers (also queens) and unfertilized eggs produce drones.
5. Her function is to lay eggs. A good queen can lay 1500-2000 eggs per day.
6. She does not have motherly instinct or ability to feed the brood. She is fed lavishly by a large number of nurse bees with highly nutritious food known as royal jelly.
7. Life span 4-5 year.



Worker

Workers are imperfect females. They are unable to mate though may start egg laying, if a colony remains queen less for long period. The workers perform all the useful work in the colony. Life span is 4-6 weeks/ 1-1.5 months.

The Duties are Related to the Age of the Worker

Age of Worker Bee	Duties performed
a) Till 3rd day of emergence	Maintain wax cells in sanitary state, cleaning their walls and floors after the emergence of young bees.
b) From 4th -6th day of emergence	Feed older larvae with mixture of honey and pollen.
c) From 7th -11th day of emergence	Hypo pharyngeal glands (food glands) get developed and start secreting royal jelly and feed younger larvae.
d) From 12th to 18th day	The bees develop wax glands and work on building of comb, construction of cells etc., Receive the nectar, pollen, water, propolis etc., from field gatherers and deposit in the comb cells and help in keeping the brood warm.
e) From 18th to 20thday	Perform guard duty
f) From 20th day onwards	The worker bees take the duty of field i.e. exploring or foraging for nectar and pollen; collecting water and propolis

Drone

1. Drones neither perform any duty inside the hive nor do they collect food from flowers.
2. Each drone is fed by 3 to 4 worker bees.

3. A colony rears and tolerates the drones only during breeding season when new queens are being produced and are later driven out of the colony to die of starvation.
4. The sole function of a drone is to mate once which costs him his life. Life span of drone is Dies after mating.
5. Maximum life of drone honey bee in summer is 59 days.

Life Cycle

The developmental stages of honey bees are: egg, larva, pupa and the adult.

Duration of life stages of different castes of honey bee varies which is given in the table and presented through Fig below:

Caste	Egg period (days)		Larval Stage (days)		Pupal Stage (days)		Total (days)	
	A. cerana	***A. mellifera***	*A. cerana*	***A. mellifera***	*A. cerana*	***A. mellifera***	*A. cerana*	***A. mellifera***
Queen	3	**3**	5	**5**	7-8	**8**	15-16	**16**
Worker	3	**3**	4-5	**5**	11-12	**12-13**	18-20	**21**
Drone	3	**3**	7	**7**	14	**14**	24	**24**

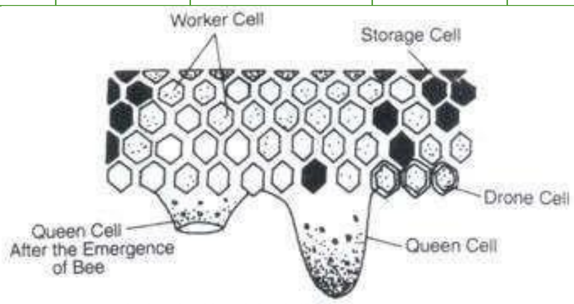


Fig. 3. A portion of the honey comb.

Portion of honey comb
Point of attachment to substratum
Cells for honey storage
Cells for pollen storage
Worker brood cell (smallest), hexagonal with flat cap
Drone brood cells (large), spherical with convex cap
Queen brood cell (largest), cylindrical and large

Dances of Honey Bees

It was Father Spitzner in 1788 who for the first time described bee dances as method of communication among inmates of the hive about volume of honey flow and place of source of nectar. These observations remained unnoticed till Frisch (1920) published his observations.

Karl von Frisch got noble prize in 1973 (under physiology & medicine, who shared it with two other animal behaviourists) on the basis of his work published in 1946.

There are 2 types of dances, the 'round' and more commonly known 'waggle tail' dance.

Round dance: The round dance is used for food sources 25-100 meters away from the hive or closer. After distributing some of her new-found nectar to waiting bees the scout will begin running in a small circle, switching direction every so often. After the dance ends food is again distributed at this or some other place on the comb and the dance may be repeated three or (rarely) more times.

The round dance does not give directional information. Bees elicited into foraging after a round dance fly out of the hive in all directions searching for the food source they know must be there. Odor helps recruited bees find the new flowers in two ways. Bees watching the dance detect fragrance of the flower left on the dancing bee. Additionally, the scout bee leaves odor from its scent gland on the flower that helps guide the recruits.

The Waggle Dance: As the food source becomes more distant the round dance is replaced by the waggle dance. There is a gradual transition between the round and waggle dance, taking place through either a figure eight or sickle shaped pattern. The waggle dance includes information about the direction and energy required to fly to the goal.

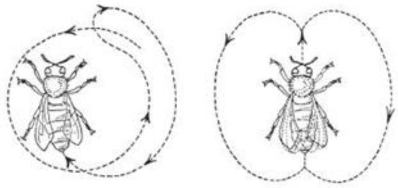


Figure 1. *Round dance* *Figure 2.* *Waggle dance*

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Methods for Reducing the Abrasive Wear on Soil Engaging Instruments

Article ID: 40607

Santosh[1], Mareppa N B[1], Sushilendra[1]
[1]Department of farm Machinery and Power Engineering, College of Agricultural Enginnering, University of Agricultural Sciences, Raichur, Karnataka, India. Pin code-584104.

Introduction

The parts of agricultural machinery and instruments that come into touch with the soil are crucial. Surfaces must have a specific roughness to be wear resistant because they are subjected to abrasive wear and occasionally impact. Surface treatment is the procedure used to achieve the required mechanical characteristics. One needs to be aware of the steel's composition and degree of hardness in order to attain the mechanical parameters. By modifying the structure of the steel, heat treatment can change the work piece's hardness, strength, and toughness. The basic procedure of thermal treatment basically involves cooling off and heating at a faster rate needed to produce the desired qualities. The temperature to which the steel is to be heated, the amount of time it is to be maintained there, the rate at which the metal is to be cooled from this heat, as well as this particular temperature, determine how the necessary attributes are included. (Spakale *et al*, 2016)

Surface modification has become a vital procedure that enhances the component's surface qualities including hardness as well as wear resistance in order to combat the numerous sorts of wear issues that steel faces. Seven categories make up the surface modification approaches. These are ion implantation, hard facing and cladding, thermal spraying, diffusion coating, thermal evaporation, electro deposition, and vapour deposition. Electro plating is a type of deposition method that modifies surfaces. Diffusion coating examples include carburising, nitriding, carbo-nitriding, chromicising, etc. (Kang 2014)

Nowadays nanotechnology is been used in many fields due to its typical property of anti-wear and corrosion. A thin film is a layer of material ranging from fractions of a nanometre to several micrometers in thickness. Deposition of thin films by Physical Vapour Deposition (PVD) techniques, such as sputtering, evaporation and reactive deposition has found wide spread use in many industrial sectors and there is an increasing demand for such coatings with enhanced properties. Sputtering is a process in which atoms are ejected from a solid target material due to bombardment of energetic particles and are deposited on substrate atom by atom.

Sputtering

Sputtering is a process in which atoms are ejected from a solid target material due to bombardment of energetic particles and are deposited on substrate atom by atom (Fig.1). Chromium nitrate (CrN) coatings are principally applied where wear and corrosion protection are major concern. It generally increases the life of the substrate.

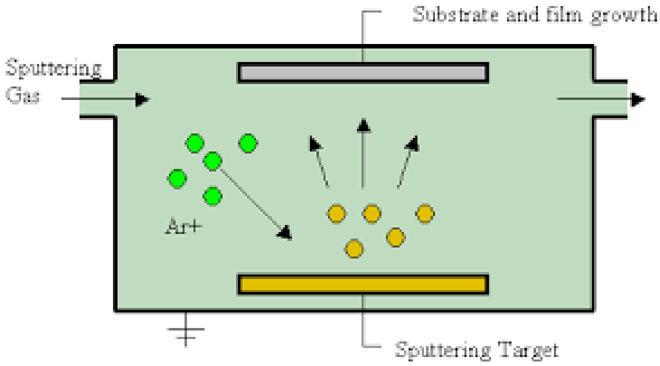

Fig. 1 Sputtering process

Carburizing

Carburizing is the method for adding carbon to the surface of low-carbon steels at temperatures between 850°C and 950°C (1560°F and 1740°F), while austenite, such as its solubility for carbon, is the stable crystalline structure. The high-carbon surface layer needs to be quenched to form martensite in order to produce a high-carbon martensitic case with good wear and fatigue resistance over a hard, low-carbon steel core.

Carburizing process (Fig. 2) increases the grains size due to permanence for a long time in the austenitic region of the phase diagram and makes necessary a posterior heat treatment to refine the grains. Classic quenching generates a martensitic hard but brittle material. On the order hand, inter critical quenching transforms the outward carbon-rich solid solution into martensite, while the internal microstructures present a mixture of martensite, producing a less-brittle material. The Pack carburizing, Gas carburizing and Liquid carburizing processes are commonly used in industrial application.

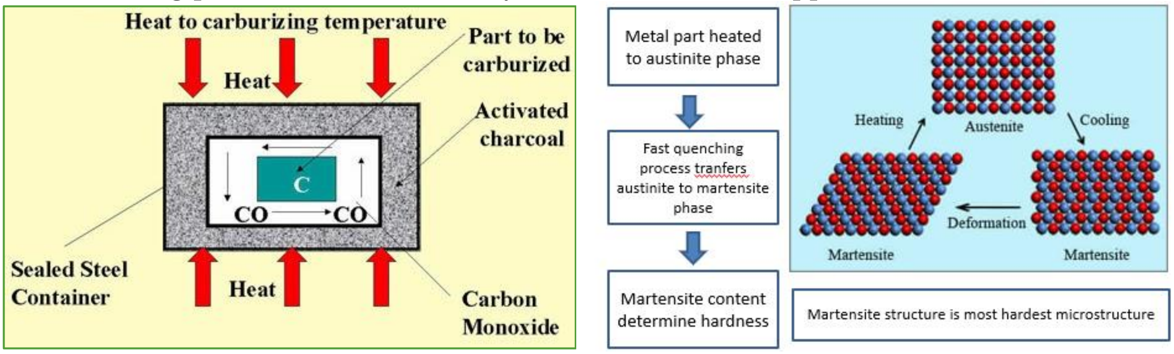

Fig. 2 Carburizing process

Hard Facing

To decrease wear or material loss due to abrasion, components can be hard faced by applying a hard, wear-resistant material to their surface via welding, spraying, or other welding methods (Fig.3). Although oxyfuel gas welding is a significant technique, it is only applicable to agricultural equipment. Hard facing is a method in which a gas flame's heat is utilised to melt the hard facing material onto the surface of the work piece. The oxy-fuel welding method for hard facing is a flexible one that may be applied to any hard facing shapes.

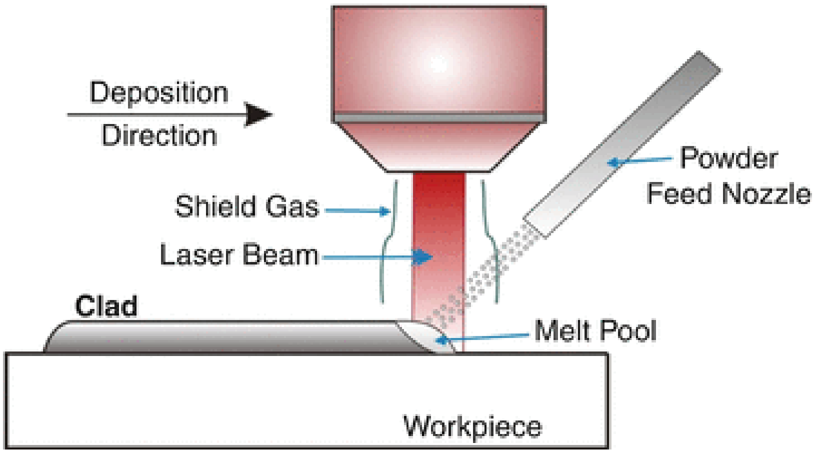

Fig. 3 Hard facing process

Shot Peening

Shot peening is a cold working process used to produce a compressive residual stress layer and modify mechanical properties of metals. In this, working surface is hit repeatedly with a large number of steel, glass or ceramic shot (small balls) which make overlapping indentation on the surface. This action causes plastic surface deformation at depth up to 1.25 mm using shot sizes that range from 0.125 mm to 5 mm in diameter.

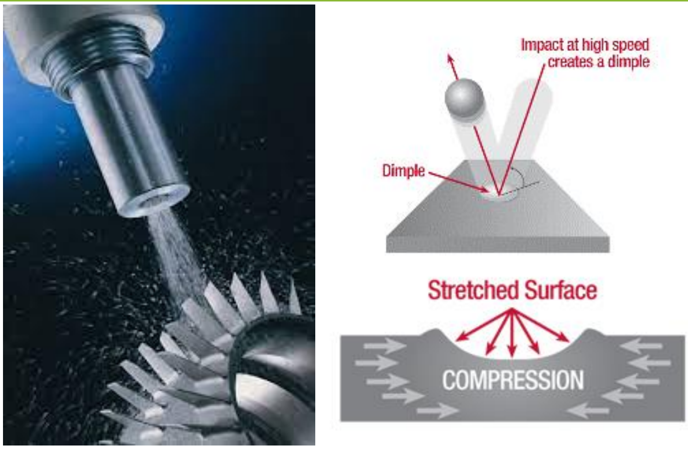

Fig.4 Shot peening process

Flame Hardening

Flame hardening is a type of heat treatment in which the gear-tooth surface that needs to be made harder is directly hit by oxy-fuel gas flames before being quenched. Over a softer inner component, it produces a coating of martensite that is hard on the surface. Contrary to induction hardening, it is significantly cheaper.

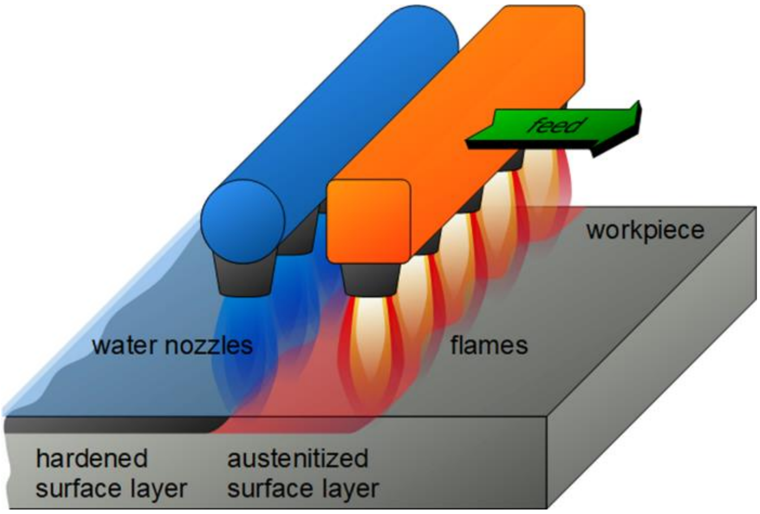

Fig. 5. Flame Hardening process

Conclusion

The wear of critical components has an economic significance, which may be largely controlled by surface modification such as sputtering, hard facing, carburizing, shot peening and Flame Hardening to increase the useful life shell of agricultural tools. In this context, there is a need of innovations, which may increase the life of agricultural tools and which in turn contribute towards the economy of the farmer as well as agriculture growth in India considerably.

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Soybean: Pulse and Legume

Article ID: 40608

J. D. Khumukcham[1], K. Tandekar[2]

[1]Ph.D. scholar, Division of Genetics and Plant Breeding, ICAR-Indian Agricultural Research Institute (IARI) New Delhi-110012.

[2]Scientist, AICRP on MULLaRP, Department of Genetics and Plant Breeding, Indira Gandhi Krishi Vishwavidyalaya, College of Agriculture, Raipur, Chhattisgarh. 492012.

Abstract

Soybean (*Glycine max* L. Merrill) is the world's most important seed legume, which contributes to 25 % of the global edible oil, about two-thirds of the world's protein concentrate for livestock feeding. Soybean meal is a valuable ingredient in formulated feeds for poultry and fish. Chinese medical compilations, dating back 6,000 years, mention its utilization for human consumption. To the populace of China, Japan, Korea, Manchuria, Philippines, and Indonesia, for centuries, soybean has meant to be meat, milk, cheese, bread, and oil. This could well be the reason, why in these countries, it has earned epithets like "Cow of the field" or "Gold from soil". Owing to its amino acids' composition, the protein of soybean is called a complete protein. Its nutrition value in heart disease and diabetes is well known. It is significant that Chinese infants using soybean milk in place of cow's milk are practically free from rickets. Keeping in mind the nutritional rich of soybean, there is a need to outlook the constraints faced by the majority of farmers in adoption of improved production technology of soybean.

Keywords: soybean, nutrition value, constraints, technology.

Introduction

Soybean is one of the most important oilseed crops in the world, and its production dominates world oilseed followed by cotton seed, groundnut and sunflower. Its seed contain 18-20% oil and 40% protein. As per AMIS, FAO estimates, among the major soybean growing countries, India ranks fourth in terms of area and fifth in terms production. In India it is third largest oilseed crop next only to Groundnut& Mustard. It grows in varied agro-climatic conditions. It has emerged as an important commercial crop in many countries and international trade of soybean is spread globally. Several countries such as Japan, China, Indonesia, Philippines, and European countries are importing soybean to supplement their domestic requirement for human consumption and cattle feed. It is a cream-colored oval bean about the size of a common pea. Soya is a frost-sensitive summer annual and plants may reach 1 metre high. Seeds are borne in hairy pods, which grow in clusters of three to five; each pod contains two or three seeds, which resemble peas. It has been an important protein source for millions of people for over five thousand years. It can be grown on a variety of soils and in a wide range of climates. Soybean is a *kharif* crop in India and is sown in June–July and harvested in late September–October. Peak arrivals begin from October and November. Soybean is a hot weather crop suitable for year-round growth in most parts of the tropics. Temperatures of at least 15^0C are needed to germinate the seed and mean temperatures of 20-25^0 C to grow the crop. Soybeans need at least moderate soil moisture in order to germinate and for seedlings to become established, but need dry weather for the production of dry seed (note that fresh, green seed for immediate consumption can be produced during the rainy season). Soybeans suffer if the soil is waterlogged. Established soybean plants can withstand considerable drought, at later stage.

Indian Scenario

Soybean is the major oilseed crop in India. Soybean has become an important oilseed crop in India in a very short period with maximum area under cultivation. India is divided into five agro-climatic zones for soybean cultivation. These are northern hill zone, northern plain zone, north eastern zone, central zone, and southern zone. There are specific varieties released for each zone which are suited to their agro-climatic conditions. There has been an unprecedented growth in soybean; area with 9.30 million ha in 2010 and has reached to 13 million metric tons in 2022. The year wise area, production and yield are presented in Fig 1. The major soybean growing states in India are Rajasthan, Madhya Pradesh, Maharashtra, Chhattisgarh, Karnataka and Telangana. Among the major growing states Madhya Pradesh has been the major contributor to the soybean area and production, currently contributing 59 % of area and production followed by Maharashtra with a contribution of 28 and 26 % in terms of total area and production of the country. Soybean is the only oilseed crop that can be cultivated successfully in Chhattisgarh during the *Kharif* season. Chhattisgarh ranked 7th in terms of India's sowing area, estimated production and 6th in expected yield. Important soybean growing districts in Chhattisgarh are Rajnandgaon, Kabirdham, Durg, Bemetara, Mungeli and Raipur. Soybean crops cover approximately 0.513 lakh ha in Chhattisgarh, with 0.467 lakh metric tonnes of production and a productivity of 910kg/ha in *Kharif* 2021.

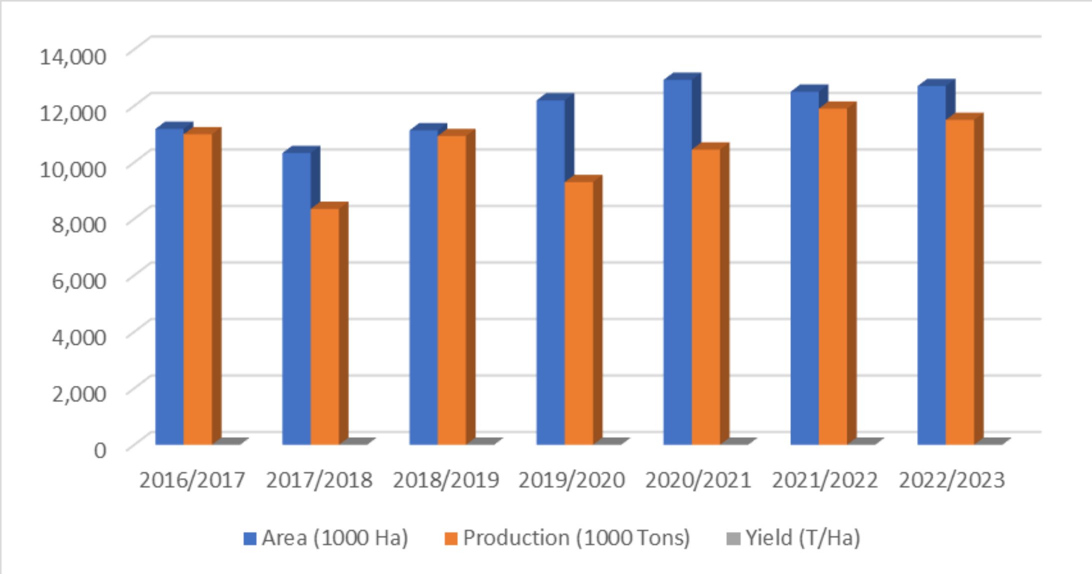

Fig: 1 Year wise increase in soybean production

Constraints to Soybean Production

1. India's soybean production declined sharply in the marketing year 2021-22 (October-September) as erratic rainfall during the sowing season affected yields, according to a survey by S&P Global Platts. A poor soybean crop could increase India's reliance on edible oil imports and endanger its exports of soybean meal in the coming months, analysts said.

2. India's soybean production in MY 2021-22 was expected to be around 10.8 million mt, nearly 16.6% lower on the year, an average estimate of 13 analysts and traders showed. India harvested 12.9 million mt of soybean in MY 2020-21, according to ministry of agriculture.

3. Soybean, the largest-grown oilseed in India, is sown in June-July and harvested in September-October. India's agriculture ministry is expected to release its production estimates later this month.

4. The likely decline in the output is primarily due to an expected fall in yields due to erratic showers, analysts said.

5. According to India's ministry of agriculture, planted area under soybean was at 12.2 million hectares in 2021-22, slightly higher than 12.1 million hectares in 2020-21.

6. However, the area in Madhya Pradesh, India's primary soybean growing state, was nearly 5% lower on the year at 5.6 million hectares, according to the ministry data. Madhya Pradesh usually produces 6.5 million mt of soybeans in a year.

7. "Market participants see the planted area to be lower than the government's estimates due to a lack of rainfall during the crucial sowing season," said an official with an edible oil trading firm.

8. Meanwhile, the Soybean Processors Association of India pegged the total planted area under soybean at 11.6 million hectares.

9. According to the association, over 41% of soybean crop planted remains in good-to-excellent conditions.
10. It has also projected that crop over 13.8% of the planted area is in poor condition, with Madhya Pradesh accounting for 55% of it.

11. "The poor condition of the crop is primarily due to poor rainfall across key producing regions," an official with a multinational trading firm said.

12. According to the India Meteorological Department, monsoon rains in India during June 1 to Sept. 15 were 4% lower from the average. In Madhya Pradesh, rainfall was 5% lower from the average during the same period.

Consideration and Suggestion to Overcome the Various Constraint in Soybean Production

1. Improving productivity of soybean through development of new gene technologies.
2. Enhancing and enriching the gene pool to broaden the selection pool along with gene flagging to assign the worth to our genetic wealth.
3. Development of new varieties that would fit into futuristic crop management regimes and can harness the opportunities created by shift in weather patterns.
4. Exploitation of heterotic vigour to create an opportunity window for development of hybrids for further increasing the yield potential.
5. Exploitation of new biotechnological tools in exercising efficient selection in reduced time frame.
6. Development of varieties with efficient extraction metabolism to assimilate ever limiting phosphorous and zinc availability.
7. Breeding varieties that could cope with abiotic stresses like water deficit and excesses.
8. Using zinc-finger nuclease technology, the trypsin inhibitor and other undesirable genes can be deleted or modified. A thaumatin gene for sweet protein gene and cloning of omega and hydroxyl acids genes can make soybean the most valuable oil crop. There are no limitations of technology. Imagination and bold decisions to do are the scarce virtues holding soybean back.

Conclusion

Considering the constraints faced by the farmers in major soybean growing states of India, lack of education and lack of knowledge were the two major personal obstacles faced by the farmers. Concerning economics level constraints high cost of pesticides, high cost of seed and high cost of fertilizer and the major constraints related to technical were lack of knowledge about identifying the disease, lack of knowledge about identifying the pests and lack of technical knowledge about soybean cultivation. Regarding the socio-economic constraints faced by respondents were the credit acquisition at the proper time and proper amount, high rate of interest and small land holding. Lack of social engagement was the primary socio-psychological barrier in implementing soybean production technology. However, non-availability of information at proper time and proper amount were the major informational constraints. the respondent's main technological constraint was a lack of irrigation infrastructure, non-availability of input i.e., Seed, fertilizer and un availability of chemical for plant protection. For removing the constraint farmers suggested to provide the irrigation facility. Extension agency should work properly, credit facility should be provided at proper time and most require input should be supplied at proper time, were the major suggestion from the farmers' side. Regarding the adoption of technology to improve the yield, farmers can approach the new AI based tools for the better results.

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Scientific Cultivation of Bhindi

Article ID: 40609

Ram Babu Sharma[1], Arvind Kumar Singh[2]

[1]Assistant Professor-Cum-Scientist (Plant Pathology), Pt. Deendayal Upadhyay College of Horticulture & Forestry (RPCAU, Pusa, Samastipur), Piprakothi, East Champaran, Bihar. Pin- 845429.

[2]Senior Scientist and Head, Krishi Vigyan Kendra (RPCAU, Pusa, Samastipur), Piprakothi, East Champaran, Bihar. Pin-845429.

Introduction

Bhindi (*Abelmoschus esculentus*) is a common vegetable crop belongs to the family Malvaceae. Bhindi is also known as Okra and Ladies Finger. The major Bhindi growing states in India are Uttar Pradesh, Bihar, West Bengal and Orissa. It is mainly grown for its green tender nutritive fruits. Dry fruits and their skin are useful in paper industry and fibre extraction. It is also rich source of vitamins, protein, calcium and other minerals.

Soil: Bhindi can be cultivated in wide range of soil. The ideal soil for Bhindi cultivation is sandy loam to clay loam with rich organic matter and better drainage facility. If proper drainage is available it can grow well in heavy soils. The pH of soil should be 6.0 to 6.5.

Important varieties: Prabhani Kranti, Arka Abhay, Arka Anamika, Pant Bhindi-1, Kashi Pragati, Kashi Bibhuti, Kashi Leela, Pusa Sawani and Rashmi.

Hybrid Varieties: Bhawani, Krishna, Kashi Bhairav Kashi Mahima.

Land Preparation: The land is prepared by giving 4-5 deep ploughings and levelling is done by two or three planking. Apply well decomposed cow dung @200 q/ha in soil at time of last ploughing. Ridges and Furrow type of layout is use.

Time of sowing: For summer season it is cultivated in February and for rainy season, it is cultivated during the month of June-July.

Spacing: For summer season crop row to row spacing is 45 cm and plant to plant spacing is 30 cm. For rainy season crop row to row spacing should be 50 cm and plant to plant distance is 45 cm

Seed Rate: For summer season crop seed rate is 15-18 kg/ha and for rainy season crop seed rate is 8-10 kg/ ha.

Seed Treatment: Seed germination can be enhanced by soaking the seeds in water for 24 hours. Seed treatment with Carbendazim will protect seeds from attack of soil born fungus. For that soak the seeds in Carbendazim solution @ 2gm/litre of water for half an hours and dry them in shades. Then immediately complete sowing. For better germination and also to protect crop from soil insect, treat the seed with Imidacloprid @5ml/Kg seed.

Fertilizer: FYM: 200q/ha, Nitrogen-120kg/ha, Phosphorus- 60 kg/ha and Potash-60 kg/ha. Half dose of Nitrogen and full doses of Phosphorus, Potash and FYM should be applied as basal dose and remaining half dose of Nitrogen to be top dressed at 35-40 days after sowing.

Weed Control: First weeding is done after 20-25 days of sowing and second weeding is done after 40-45 days of sowing. Pendimethalin @2.5 liter /ha is used as pre-emergence herbicide for controlling weeds in Bhindi.

Irrigation: Pre sowing irrigation should be given in summer season crop to ensure good germination if sufficient moisture is not present in soil. The next irrigation is given after seed germination. Then the field is irrigated after 4 to 5 days intervals in summer and 10 to 12 days intervals in rainy season.

Disease and Insect Management

Important diseases and their management:

1. Yellow Vein Mosaic (YVM) of Bhindi: This is an important viral disease of Bhindi causes yield losses up to 80-90%. Yellowing of the entire network of veins in the leaf blade is the characteristic symptoms of

YVM of Bhindi. In severe infections the younger leaves turn yellow, become reduced in size and the plant is highly stunted. The veins of the leaves will be cleared by the virus and interveinal area becomes completely yellow or white. The infection of the disease may start at any stage of plant growth. The affected plants produce fruits with yellow or white colour and they are not fit for marketing. This disease is spread by white fly.

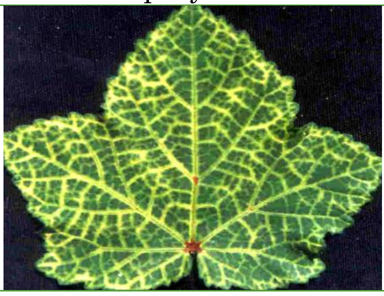
Management: Use resistant varieties for cultivation. Uproot the diseased plants. To manage white fly spray the crop with Imidacloprid 17.8 SL @0.5ml/liter water @ 1.5 ml/liter of water.

2. Powdery mildew: White powdery growth is observed on young leaves and also on fruits. In severe condition premature defoliation and fruit drop is observed. Fruit quality get deteriorated and they remain small in size.

Management: Spray of Wettable Sulphur Powder 2.5gm/liter of water or Dinocap@ 0.5 ml/liter of water, three times at 10 days intervals.

3. Cercospora leaf spot: The main symptoms of the disease appears as brown spot having greyish centre and red borders on the leaves. In case of severe infestation, defoliation occurs.

Management: Seed treatment with Thiram @ 2g/kg seed. If the symptoms of disease are observed in field spray Mancozeb @ 2.5 gm/liter or Carbendazime@2gm/liter of water. Or give two - three foliar sprays of Hexaconazole @ 0.5ml/litre of water.

		
Infected leaf with YVM	**Powdery mildew**	**Cercospora leaf spot**

Important Insects and their Management

1. Shoot and Fruit borer: During vegetative stage larvae bore into the shoots resulting in drooping of affected shoots. In later stages bored fruits have larvae inside and filled with excreta.

Management: Cut the infested parts. If pest population is high, spray Spinosad@1ml/liter of water or Chlorantraniliprole 18.5% SC (Coragen) @7ml/15 liters of water.

2. Aphid: Adult and nymphs, both suck the sap thus weaken the plant. In severe infestation, they cause curling and deformation of young leaves. They secrete honey dew like substance and sooty, black mould is developed on affected parts.

Management: Apply Imidacloprid 17.8 SL 0.5ml/liter of water at 20 to 35 days after sowing.

Harvesting and Yield: The fruits are ready to harvest after 60 to 70 days of sowing. Small and tender fruit should be harvested. The fruits should be harvested in the morning and evenings. Delay in harvesting may make the fruits fibrous and they lose their tenderness and taste. Rainy season crop gives 120 -150 q/ha. Summer crop gives 80 -100 q/ha yield.

Benefits, Uses, and Everything About Goat Milk

Article ID: 40610

Pranjali B. Meshram[1], Abasaheb K. Parade[1], Chetan Chougale[1]
[1]Ph.D Research Scholar, Department of Animal Husbandry and Dairy Science, Mahatma Phule Krishi Vidyapeeth Rahuri-413722, Ahmednagar (MH).

Introduction

Goat milk is the most used dairy in the world. Its consumption level is so high that it has almost 65-72% of the global dairy consumers. It is also because of the ease of keeping goats compared to cows. It is especially true in the case of developing countries where there is a lack of resources for the general population. Moreover, goat milk has good calories, proteins, and fats. Therefore, most people prefer goat milk over cow milk.

What distinguishes goat milk from other forms of milk is its thickness and creaminess. It has numerous health benefits too. For example, it is easier to digest, has less risk of causing milk allergies, and promotes better heart health.

Uses of Goat Milk

We have several options for attaining maximum goat milk benefits. It is recommended that one should drink raw goat milk. We can usually buy it from our local farmers' market or health food stores.

Nutritional Information

Goat Milk: A cup of goat milk has:

a. Calories- 170
b. Protein- 9 grams
c. Fat- 10 grams
d. Carbohydrates- 11 grams
e. Sugars- 11 grams
f. Cholesterol- 25 milligrams
g. Is Easily Digestible
h. May Promote Heart Health
i. May Help Fight Inflammation
j. May Strengthen Bones
k. Could Be a Good Metabolic Agent
l. May Help Relieve Anxiety.

Goat Milk Vs. Cow Milk – Which is Better?

Serving size = 1 cup (244 g)

Both types of milk have similar amounts of lactose. While 100 grams of goat milk has 4.1 grams of lactose, the same amount of cow milk has 4.6 grams of lactose. Goat milk also enhances the body's ability to absorb certain nutrients from foods.

Goats Milk	Cows Milk
Dairy goat farms are smaller, goats are allowed more free range, antibiotic use hormones, such as the highly controversial bovine growth hormone is kept to a bare minimum, and (rBGH), are not used.	Dairy cow farms are bigger in scale, cows have limited space, higher chance for infectious diseases outbreak and use of antibiotic may be a need. Use of Growth hormone (rBGH) is more common too.
Hypoallergenic, people who can't tolerate cows milk may be able to tolerate goats milk well	Many allergic cases reported with the use of cows milk
The closest to human milk	Far from human milk
Lower lactose content, 7% lower than of Cows Milk	May contain high lactose
Smaller fat lobule size that enhances digestibility	Bigger fat molecule, difficult to be digested

Nutritional and Medicinal Importance of Goat Milk

1. Good for Skin: Milk is an active ingredient for improving skin conditions. it helps reduce acne and blackheads. it helps moisturise, smoothen, and whiten your skin.

Goat milk and human skin have the same skin pH. It means that when you use goat milk to cleanse your skin, it does not disturb the skin's natural microbiome or acid mantle. So, if you have sensitive skin issues like psoriasis or eczema, goat milk will help immensely.

2. Promotes a Healthy Weight Gain: A healthy weight lowers the risk of heart disease, stroke, diabetes, and high blood pressure. Furthermore, it also prevents the chance of contracting cancer. Compared to other milk types, goat milk has more calories per serving. However, it has a similar nutritional profile to cow's milk. Therefore, the extra calories lead to a healthy weight gain.

3. Goat Milk is Easier to Digest: The fat globules in goat milk are 20% smaller than cow's milk. Then easier to digest. It is also lower in lactose, making it an excellent alternative to cow milk for people suffering from lactose intolerance.

4. Increases Platelet Count: Dengue fever's significant complications are selenium deficiency and a drop in blood platelet count. However, goat milk may help treat dengue patients by increasing blood platelets. That is because selenium is its main component. In addition, it also helps with the digestive and metabolic utilisation of various minerals present in the body.

5. Goat Milk Helps Prevent Milk Allergies in Kids: Goat milk has a good amount of A2 casein. For example, 100ml of goat milk contains about 3.6 grams of A2 casein. A2 casein has high protein levels, just like human breast milk. Therefore, it prevents inflammatory diseases of colitis and irritable bowel syndrome. Usually, babies are given goat milk as the first source of protein after breastfeeding. That makes them less prone to milk allergies than cow's milk.

6. Prevents Insulin Resistance: An adequate amount of insulin help to balance blood glucose levels. It also restores the leftover glucose in your liver when your bloodstream has excess glucose. Goat milk prevents insulin resistance. Insulin resistance increases blood sugar levels in the body. As a result, it can eventually lead to type 2 diabetes.

7. Helps Reduce Cholesterol Levels: Goat milk may cause an increase in the biliary secretion of cholesterol. It leads to a decrease in plasma cholesterol concentration. People with problems like high blood cholesterol should have goat milk. It may help reduce cholesterol levels in the arteries and gall bladder.

8. Prevents Anaemia: Goat milk is rich in calcium, iron, magnesium and phosphorus. Our bodies easily digest and absorb these minerals. As a result, goat milk helps treat nutritional deficiencies such as bone demineralisation. It also fixes iron and magnesium deficiency. It further enhances the ability of the body to use iron. Goat milk boosts the formation of RBCs too. Therefore, patients suffering from anaemia, mal-absorption issues, or osteoporosis should consume goat milk.

Best Ways to Use Goat Milk

Goat milk is an excellent replacement for milk products in any recipe.

 1. Goat Cheese Made with Lemon Juice	 2. Goat Milk Fudge	 3. Goat milk caramel	 4. No Egg Nutella Ice Cream
 5. Avocado Cream Dessert with Goat' Milk	 6. Caramel Apple Cider Ice Cream	 7. Goat milk Burfi	 8. Goat Milk Butter

Goat Milk: Side Effects

Like any kitchen staple, goat milk can also cause some side effects to our body. The important thing that we need to remember is to avoid raw goat milk consumption. Consumption of raw milk can be the cause of you getting hospitalised. Some of the common side effects of consuming raw goat milk are as follows: Diarrhoea, Nausea, Vomiting, Stomach cramping, Dysentery, Food poisoning, Brucellosis, Tuberculosis, Night sweating, Guillain Barre syndrome, Paralysis, Kidney failure, Stroke.

Conclusion

Goat's milk is full of nutrients. It even has a high nutritional level than cow's milk. So, it helps us absorb certain nutrients too. It is a more nutritious and natural option for protein, calcium, and fats. These are the reasons for its highest worldwide consumption. By following the precautions and taking care of the possible side effects of having goat milk, you can easily add it to your daily diet. Remember, 200 ml or three servings of goat milk fulfils the individual calcium requirement.

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Heat Stress and it's Management in Broilrs

Article ID: 40611

Abasaheb K. Parade[1], Pranjali B. Meshram[1], Akshay P. Chawke[1]
[1]Ph.D Research Scholar, Department of Animal Husbandry and Dairy Science, Mahatma Phule Krishi Vidyapeeth Rahuri-413722, Ahmednagar (MH).

Stress

In medical terms stress is described as, "a physical or psychological stimulus that can produce mental tension or physiological reactions that may lead to illness."

Or

Stress is defined as a non-specific response of the body to any demand from the environment. Stress can alter the steady state of the body and challenge physiological adaptive processes.

Introduction

High temperature and humidity increase the stress of the birds reducing their activity and the feed intake, increasing the risk of diseases. The results are lower feed efficiency, increased mortality, lower profits. Heat stress produces heavy loss to poultry industry every year. Poultry industry has shown a spectacular growth during the last three and half decades. Poultry industry had been the most dynamic and fastest growing sector of livestock economy. The broiler industry is growing at the rate of 12-15 per cent per annum over the last few years. As a result, India today has emerged as one of the largest egg and meat producers in the world.

Importance

1. Production of healthy birds
2. Prevent disease outbreak
3. Prevent heat stroke
4. To reduce mortality
5. Constant supply of broilers marriages, food parlours, restaurants, hotels, etc.
6. Maximum return of fund
7. Implementation of the management.

Susceptibility

Birds are susceptible to high Environmental temperature due to- Absence of sweat glands. Feathered body. Fatty nature. High body temperature. Broilers than layers. Male broilers are more susceptible.

Heat Produced: Bird is producing heat through Metabolic processes and Muscular activity. Ideal temperature for Performance is 19-22°C in laying hens. 18-22 °C in broilers. Body temperature of chickens began increasing when the ambient temperature increases above 30 °C

Heat loss: Occurs through conduction, convection & radiation.Occurs through panting(evaporative heat loss) Begins when temperature reaches 29° C. Bird also reduce heat by raising and spreading her wings. Separating herself from other birds.

Effect of Heat Stress on Broiler: Body temperature rises, Chickens devotes less time to walking and standing Heart rate is lowered. Respiration rate increases 2.7 times. Water consumption increases 50-60%. Feed intake decreases. Blood calcium level decreases to 25-30% Watery droppings.

Reduced body weight, Blood pH in broilers increased at higher AT, Blood pressure reduced, Death also, Decreased growth & increased muscle degradation, Less formation of WBCs, Blood calcium level decreases to 25-30%.

Techniques to reduce Heat Stress: Genetic strategies, Selection for heat tolerance, Effect of heat stress is more in Commercial broiler stocks with high growth potential compared to slower growing chicks. Fast producing broilers produce more heat & have high heat load & high mortality. Therefore, comparatively slow growing lines are chosen. Naked neck gene. Naked neck gene reduces feather mass by 20% & 40% respectively. Naked neck genes result in higher growth rate & meat yield than their feather counter parts under normal temperature & effect is more pronounced at high temperature Frizzle gene. Reduce heat insulation of feathers by curling feathers & reduce their size. Effect of F gene on broiler growth at high temperature is less than of Na allele. Effect is only significant in slow growing line. Dwarf gene, dw gene results in reduction of 30%- 40% of adult body size.

Housing Management

Site & planning:

- **a. Orientation:** Long axis should be East-West
- **b. Shade:** Trees
- **c. Air movement:** Perpendicular to Prevailing Wind direction.
- **d. Building width:** 10-12m is preferable.
- **e. Roof:** Gable or shed roof along with ridge vent to provide an escape for hot air at roof peak is desirable.
- **f. Floor:** Concrete floors are desirable for easy Cleaning & Disinfection.
- **g. Wall:** Should be water proof & poor conductor of heat.
- **h. Insulation:** Should be placed below the roof as it will prevent influx of heat into the building.
- **i. Painting & White washing:** Outside of walls & roofs should be painted white or covered with material which will reflect heat.
- **j. Ventilation:** For elimination of already heat produced proper ventilation is necessary. Not more than 13m wide & 4m in height.

Natural Ventilation: Curtain-sided houses rely extensively on natural air movement. Located away from obstructions (Trees, buildings).

Forced Ventilation: All air movement is produced by fans in the building walls. Houses that use this type of ventilation are also referred to as controlled environment systems. Uniform airflow patterns.

Evaporative Cooling

Fan Pad System:

- a. Most effective method of cooling in low humidity.
- b. Air is drawn through adsorbent, porous cooling pads or through fan pad system.
- c. Cooling of warm air is attained by its contact with water.
- d. Air cools & there is increase in RH.
- e. Aspen fiber and corrugated cellulose are two materials widely used as cooling pads.

Fan Pad System

Fan Fogger System:

a. The foggers inject fine water particles into the warm inside air.
b. As the water vaporizes, heat is absorbed from the air, lowering its effective temperature.
c. Foggers reduce air temperature in the house on hot days (32 ° to 35 ° C).

Fan Fogger System

Feeding Management

Energy Requirement- ME Requirement decrease with increase in temperature. Lowest at 28-30°C followed by increase up to 36°C. Reduced energy intake is associated with reduced growth rate in heat stress. Feeding of high energy rations can overcome this growth rate depression. Higher fat content of feed also contributes to lower heat production. Growth rate & feed utilization of heat stressed bird gets improved. Food intake & growth rate got improved by increasing ME of diet & decreasing proteins.

Protein & Amino Acid Requirement

1. Protein requirement is decreased bz of suppression in Production performance.
2. High protein diet during heat stress decrease growth rate & meat yield.
3. Protein has high heat increment.
4. Diets containing lower protein levels & supplemented with limited amino acids, methionine, lysine gave better results.

Vitamin Requirement

Decreased nutrient intake at high temperature decreases intake of micro nutrients. Supplementation of these nutrients is helpful for maintenance of performance & immune function.

Vitamin C: Under heat stress, birds are not able to synthesize the sufficient amount of vitamin C. Vit C @ 1000mg/kg Supplementation of ascorbic acid. Heat resistance, Carcass quality, Act as antioxidant reduce oxidative injuries, Reduce mortality.

Vitamin A: Detrimental effect on Production by heat stress can be alleviated by dietary suppl. of Vitamin A @ (9000 IU/kg) Increase feed intake, for immunity of heat stressed bird, Alleviate the oxidative injuries induced by heat Exposure.

Vitamin E: @ 250mg/kg – Acute stress, Supplementation is associated with Increase in feed intake, Improve Immune system, Act as antioxidant.

Mineral Requirement

Blood acid balance is disturbed by hyperventilation and results in respiratory alkalosis. Respiratory Alkalosis suppress growth rate & egg shell quality. Suppression of growth can be partially alleviated by supplementation of:

a. 1% NH_4Cl
b. 0.15% - 0.6% KCl
c. 0.2% $NaHCO_3$.

Supplementation of electrolytes in water enhance:

a. Water consumption.
b. Increase tolerance to heat stress.

Improve production performance.

Other Management

Water: Water requirement increase during hot periods. 6% water intake increase per degree rise in temperature from that at 20^{o}c temperature. 25% more drinking space should be provided. Water below body temperature will certainly aid in heat dissipation

Defeathering & Dewinging of broiler: Wings cover wide surface area & their presence reduce efficacy of evaporative heat loss. Body temperature and mortality was lower in dewinged group. Beak trimming. To prevent feather picking & Cannibalism which is more in hot climate.

Litter management: Litter should be at least 5 cm depth, & in good condition during Stocking Density Stocking density should be reduced by 10% in Summer

Disease Management: Heat stress makes birds more susceptible to various disease conditions. Coccidiosis Incidence of coccidiosis should be checked as it will aggravate the heat stressed birds Anticoccidial drug Nicarbazine exert delerious effect in heat stressed birds. Mycotoxicosis Most imp cause of Mortality in chicken during Hot Humid season. Best control of Mycotoxin formation is to prevent the development of fungi in feed stuffs.

Conclusion

1. Broilers under heat stress were to make critical physiological adjustment. Feed intake is depressed and water intake is increased.

2. Dietary adjustments can help reducing metabolic heat production and maintain nutrient in the energy intake and amino acid balance is of extreme importance in that heat stress.
3. Providing adequate ventilation and stimulating water consumption is essential.
4. Minimizing bird activity during the hottest parts of the day lessers the heat burden, controlled fasting is beneficial and usually increases survival rate of broilers during summer season.
5. Thus, there will be economic gain in broiler production even in adverse weather.

Nematode Resistance Breeding in Vegetable Crops

Article ID: 40612

Manisha[1], G Naryana Swamy[2]
[1]Assistant Professor, Department, of Horticulture, Centurion University of Technology and management, Paralekhemundi, Odisha.
[2]Ph.D. (Inservice)- ICAR-Indian Agricultural Research Institute-IIHR Bengaluru; SMS (Horti.,) & amp; KVK, Nellore.

Root-knot nematodes (*Meloidogyne incognita*) are sedentary endoparasites. This species is most common major pathogen of many crops throughout the sphere, impacting both the quantity and quality of marketable yields. Integrated nematode management approach is better approach to menace Root knot nematodes in crops. As part of the Integrated nematode management approaches Host plant resistance is the cost effective, environmentally safe and eco-friendly alternative approach than other practices and also thus reduce environmental pollution and facilitate safe food for human consumption. Conventional and Biotechnological breeding tool's major role in developing host plant resistant cultivars or varieties against to Root knot nematodes. Information on source of resistance is important for the development of resistant varieties and pre-breed lines. Further, gene action responsible for the inheritance of characters helps in the choice of suitable breeding methods for the improvement of the crop. The search for sources of nematode resistance in crop plants and the use of varieties having such resistance in reducing the nematode population and damage caused by them constitute one of the well-known approaches of plant protection research The sources of root knot nematode resistance, genetics and inheritance of root knot nematodes resistance in vegetables and also useful to help breeders to plan improvement experiments, multiple resistant varieties developing programmes against Root knot nematodes. The search for sources of nematode resistance in crop plants and the use of varieties having such resistance in reducing the nematode population and damage caused by them constitute one of the well-known approaches of plant protection research. This method of nematode control, if successfully developed, has the added advantage that it involves a heritable varietal character and therefore would be reliable and inexpensive in the long run (Moens *et al*., 2009; Molinari, 2011; Nicol *et al*., 2011).

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Future Food Production Methods Include Vertical Farming and Agriculture in Controlled Environments

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Mastu Patel[1]

[1]Ph.D. Scholar, Department of Agronomy, School of Agriculture, Lovely Professional University, Phagwara Punjab 144411.

Introduction

Impact of climate change on achieving sustainable growth of agriculture and food security is one of the potential risks to agriculture. Climate change is a genuine reality nowadays. India is among the nation's most sensitive to the effects of climate change on agricultural production, along with many other developing nations. Land degradation brought on by salinity, land fragmentation, labour issues, and over-exploitation of natural resources all have an impact on sustainable food security. Most canal command regions, particularly in developing countries, are becoming more salinized because of improper irrigation techniques. In arid regions and coastal areas, more salinity will be added to the soil and subterranean water due to changes in hydrological systems, temperature increases, and sea level rise. States also create development plans for regions. A similar apex body at the national level is the Indian Council of Agricultural Research (ICAR), which funds research and extension initiatives to develop efficient Transfer of Technology (TOT) models. In addition to applying the models developed by the ICAR system, the State Agricultural Universities are considering developing extension models suitable for technology transfer. Farmers are the primary audience for agricultural extension, and most farmers in India fall into the marginal group. Farmers' socioeconomic circumstances are not very good. Their desired situation is different from how they are now living. By advancing and disseminating appropriate research and technology in the farmer's field, Agricultural Extension will reduce this gap (Sagar Mondal, 2017).

Transfer of Technology

Technology is a by-product of scientific knowledge and the application of techniques, procedures, and methods utilised in manufacturing and academic study. Without or with full knowledge of how they work, all machines operate using technology to serve the objectives of an organisation. Technology transfer is a crucial method for getting the right technology into the hands of farmers. The process of transferring technology from its creation to its use takes time, but with government and non-governmental intervention, it can be done quickly and easily from a lab to a farmer's field. This technological distribution process is being carried out by several organisations. KVK is crucial in the front-line demonstration and on-farm testing of that specific technology. The Lab to Land Initiative was started by ICAR, an overarching agency that oversees all agricultural operations in India, to effectively transfer technologies.

Agricultural Innovation

Food demand would increase 70% by 2050 in pace with the increasing population rise. According to a UN report, 9.9% of the world's population still experiences hunger, making the idea of providing food for roughly 10 billion mouths a daunting job. Given how unpredictable environmental changes are, we must rely on advancements in agricultural technology. These technological advancements will help farmers improve the way they produce is grown, transported, stored, and managed.

Idea of a Vertical Farm

Vertical farming is the practise of growing crops inside of buildings (such a skyscraper or an old warehouse) as opposed to in the ground, which conserves water and does away with the need for soil. A vertical farm's ability to produce food is unaffected by the weather or other environmental circumstances. When grown in controlled conditions with ongoing monitoring and adjustment of environmental elements like light, humidity, and temperature, a wide range of plant species can reach ideal growth rates year-round (the vertical farm: feeding the world in the 21st century). To increase efficiency, vertical farming is being used

(Benke et al., 2017). To enable indoor food and pharmaceutical manufacturing, it is possible to artificially control the temperature, light, humidity, and gases.

Need of Vertical Farming

1. Food security
2. Climate change
3. Economics
4. Health Issues
5. The ecosystem
6. Urban density.

Modern Techniques for Vertical Farming

1. Technology Bee Vectoring: The BVT inoculum delivery system is built into the wasp nest's outer shell (Sakshi Saxena et al., 2017). In place of chemical pesticides, BVT uses commercially raised bees to offer specific crop controls through pollination. This crop protection method is safe for the environment. The technique does not require the use of tractors or water spraying. Instead, the scientifically created bumblebee hive enables the bees to carry a little amount of pest control powders on their legs as they move over the field. This advancement in agricultural technology encourages increased crop output, sustainable farming, and soil quality. The BVT system is effective for farms of all sizes and is ideal for a variety of crops, including blueberries, sunflowers, apples, and tomatoes.

2. Precision farming: Precision agriculture is a key component of the third wave of modern agricultural revolutions. Precision agriculture is a method of managing agricultural resources that collects, examines, and evaluates data and offers insights to help farmers improve and increase the production and quality of their soil (Ashish Dwivedi *et.al*2017). To improve farmland and agricultural products in a number of crucial areas, including resource use effectiveness, sustainability, profitability, productivity, and quality, precision agriculture data points are employed in management decisions.

3. Indoor vertical gardening: Farm products are grown indoors using vertical farming techniques in a controlled, enclosed setting. The method uses vertically placed growing shelves to boost agricultural productivity in constrained areas. This is either hydroponic or aeroponically grown without the need for soil: Because to its effective resource management and high-quality food output, hydroponic farming is currently becoming more and more popular worldwide (Nisha Sharma et al., 2018). Growing plants in water and fertiliser solutions is known as hydroponics. Because of its speed, low cost, and novelty, aeroponics is a relatively new method of cultivating plants that holds promise for resolving any future food shortages (Reena Kumari et al., 2019). In aeroponics, the roots of the plants are suspended in the air, and emitters sporadically spray them with water and nutrients.

4. Aquaponics: Mutualistic interactions between fish and plants can be established when hydroponic vegetable, flower, and herb production is integrated with fish aquaculture. Aquaponics is a method of growing food that combines hydroponics and aquaculture. Aquaponic systems utilise around 10% less water than traditional soil-based horticulture does. These methods can be useful in severe rural or urban contexts with limited or poor-quality land. This benefit is also accessible with a hydroponics or re-circulating aquaculture system. Aquaponics can be a significant improvement over conventional farming techniques in nations where nutrient enrichment is an issue.

	
Vertcal farming	**Bee keeping**

	
Precission farming	**Aquaponices**

The government seeks to put cutting-edge technologies into practise for the benefit of the farming sector. Several projects and programmes were launched to advance this technology. Monitoring and assessment are occasionally crucial responsibilities to spread such technology on the farmer's field. By securing high returns from their productivity, ensuring food self-sufficiency, and improving their socioeconomic status, this strategy seeks to provide the agricultural sector a new dimension. Together with the advancement of GPS-driven precision farming technologies, people have discovered new approaches to boost agricultural output and enhance food production. Technology for livestock farming gives farmers data-driven insights that help them run their farms more efficiently, take better care of their animals, and increase productivity. Being a digital checklist that delivers real-time data and statistics to help farmers keep track of daily tasks, farm management software is also an integrated platform. Farmers' decision-making across all operations can be improved with the help of this monitoring and reporting software. So, we may draw the conclusion that promoting agricultural activity by technology intervention is a highly significant duty. The farming community will benefit from it by having higher household incomes, higher levels of productivity, and better socioeconomic conditions.

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Article on Sprinkler Irrigation System

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Harshavardhan Rao Sulluru[1], Dr, Yadvendra Pal Singh[1]
[1]School of Agriculture, Lovely Professional University, Punjab.

Introduction

The sprinkler water system is a technique for applying water system water like regular precipitation (in the form of drops). Water is conveyed through an arrangement of lines, typically by pumping. It is then showered into the air through sprinklers, so it separates into tiny water drops which fall on the ground. The siphon supply framework, sprinklers, and working conditions should be intended to empower a constant use of water.

Water system sprinklers can be utilized for private, modern, and farming utilization. It is helpful on slopy land where adequate water is not accessible, just as on sandy soil. The opposite pipes, having turning spouts on the top, are joined to the primary pipeline at ordinary stretches.

At the point when water is compressed through the entire line, it escapes from the pivoting spouts. It gets sprinkled on the yield. Water is channeled to one more focal area inside the field in a sprinkler or overhead water system and circulated by overhead high pressing factor sprinklers. Sprinkler Irrigation system is an advancement in agriculture that has paved the path for a better future of agriculture.

Working Process

1. A pump unit concentrates water from the source and delivers pressure for release into the line framework. The pump should have the option to supply water at the proper pressing factor to ensure the water is released at an ideal rate and volume reasonable to the yield and soil type.

2. Central lines and optional lines convey water from the to the laterals. At times, these pipelines are introduced on the dirt surface or covered underneath the land surface. In some cases, it is moveable and can be shifted from one field to the other. The essential materials utilized for the pipe are asbestos concrete, plastic, or aluminum compound.

3. The laterals ship water from lines to the sprinklers. They can be lasting, yet for the most part, they are compact and made of aluminum amalgam or plastic so that they can be moved rapidly.

4. Sprinklers – which are the water-emanating gadgets that change and scatter the water fly into little beads. The plan of sprinklers is made to wet the dirt surface in the ideal region as equitably as expected.

Advantages of Sprinkler Irrigation

1. It helps to irrigate crops and plants in slopy areas where water is inaccessible.
2. It helps save water.
3. It gives water in the form of fine droplets like rain.
4. BY sprinkler irrigation system, we can control the quantity of distributed water.
5. When we irrigate crops with cool water, the soil is capable to properly absorb water that is beneficial for the drainage system of the earth.
6. It enhances the yield of crops.
7. Provides Optimized Soil Environment.

Disadvantages of Sprinkler Irrigation

1. Water is lost to evaporation.
2. It is not suitable for the areas exposed to high wind.
3. Installation of sprinklers is costly.

Conclusion

Sprinkler irrigation was developed initially for home lawn care and garden water use. However, while spray irrigation technology was developed for personal use, it is such a useful technology that it has quickly become one of the most common types of irrigation systems in agriculture. Farmers quickly recognised the benefits of consistent, high-pressure water delivery for their irrigation systems. Sprinklers are appropriate for use in all types of gardens, landscaping, and fields because they provide adequate coverage for small to large blocks of land. Sprinklers are adaptable and suitable for use on nearly all types of irrigable soils due to the wide range of discharge capacities available. Sprinkler systems, on the other hand, can quickly clog due to sediments or rains, and large systems have high capital investment costs.

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Biodiversity and its Conservation

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Dr. Jayanta Bhuyan[1], Dr. Nikhilesh Baruah[2]
[1]Professor, Deptt. of Plant Breeding and Genetics, Biswanath College of Agriculture, Biswanath Chariali Assam Agricultural University-784176.
[2]Junior Scientist, AICRP on Dryland Agriculture, Biswanath College of Agriculture, Biswanath Chariali Assam Agricultural University-784176.

The most fascinating feature of Earth is the existence of life, and the most fascinating feature of life is its diversity. Edward Wilson, a sociobiologist, coined the term 'biodiversity' in the year 1985 to highlight the diversity and abundance that is found in the rich flora and fauna on Earth. Biodiversity in short can be defined as "the totality of genes, species and ecosystem in a region". Diversity within species is the genetic diversity, between species is the species or taxonomic diversity and of ecosystem is the ecological diversity.

International Union for Conservation of Nature (IUCN) in 2004 has recorded the total number of known plant and animal species to be slightly more than 1.5 million. India stands 7th in the world as far as number of species contributed to agriculture and animal husbandry is concerned. Although India occupies only 2.4 percent of the world's land area yet it contributes to the world's biodiversity approximately 8 percent of the total number of species.

These species are flowering plants, mammals, fish, birds, reptiles, amphibians and constitute 17.3 percent of the total whereas nearly 60 percent of India bio-wealth is contributed by fungi and insects. India is endowed with 366 domesticated species of economic importance and 326 species of their wild forms native to the subcontinent.

Megadiversity Countries

Megadiversity country is defined as one that contains 20,000 higher plant species or, in the case of a country with fewer than 20,000 but more than 10,000 such species, at least 5000 endemics, or contains at least 2000 species of higher vertebrates. There are 17 mega diversity countries. India is recognized as an important Megadiversity country.

Hotspot

Those areas that feature exceptional concentration of endemic species and face imminent threat of habitat destruction are known as hotspots. Altogether 18 hotspots have been identified including eastern Himalayas and Western Ghats of India. To qualify as hotspot, a region must contain at least 0.5 % or 1500 of world's 270,000 vascular plant species as endemics. Secondly, a hotspot should have lost 70% or more of its primary vegetation, described as the form of habitat that usually contains the most species, especially endemics.

Significance of Biodiversity

1. Proper maintenance of biodiversity is essential for survival on earth. An area rich in diversity of species is considered to be more stable than an area in deprivation. Moreover, we rely entirely on the environment to fulfill our needs to survive.

2. It provides ecological stability by providing various services required for the survival of human life. Every species serves a specific function in an ecosystem. Some produce and decompose organic matter while others capture and store energy. An abundant and diverse ecosystem is more productive and resilient to environmental stress like droughts, floods, landslides, etc.

3. Rich biodiversity provides economic value as it is a reservoir of various resources like cattle, fishes, forests, medicinal herbs, wood, crops, etc., that are essential for the propagation of life on Earth.

4. Abundant and balanced biodiversity also provides ethical and aesthetic value by conserving the rich cultural heritage.

Conservation of Biodiversity

Rapid urbanization, industrialization, mega development projects and replacement of large number of old crop varieties with very few commercial varieties are contributing to genetic erosion. This erosion and extinction would lead to non-availability of vast gene resources to deprive future crop improvement programmes.

The IUCN Red List is a critical indicator of the health of the world's biodiversity which was first introduced in 1994. The Red List classifies plants into different categories such as Extinct (EX), Vulnerable (VU), Conservation Dependent (CD), Lower Risk (LR), Data Deficient (DD) and Not Evaluated (NE). It estimates that 20,000 to 25,000 plant species are threatened due to biotic and abiotic pressure on land mass and over exploitation by man for its welfare. IUCN Red List stating different status of plant species heading towards extinction indicates the necessity of flora conservation. The IUCN Red List is updated from time to time.

Biosphere Reserves

Biosphere reserves conserve biotic communities within natural ecosystem and help to preserve the core areas of indigenous flora and fauna and safeguard genetic diversity of species and provide natural evolution process of diversity. In India nine sites have been identified and notified as Biosphere reserves including Manas and Dibru-Saikhowa of Assam and Nokrek of Meghalaya.

Ex-Situ Conservation

Botanical gardens, herbal gardens and gene banks, etc. constitute ex-situ conservation methods. In India, the Natural Bureau of Plant Genetic Resources (NBPGR) represents the largest gene bank in the country. Cryopreservation is a potential and popular *ex-situ* plant conservation method to conserve plant parts for indefinite period. It involves the storage of viable tissues at ultra-low temperature. Liquid nitrogen is mostly used as cryogen. This is a potential long term plant preservation/conservation technology. Therefore, creation of public awareness regarding importance of biodiversity and prevention of widespread deforestation should be given topmost priority for conservation of diversity of flora and fauna.

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Management of Late Blight Disease of Tomato

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Rahul Aske[1], Dr. Deepak Kher[2]
[1]Assistant Professor, School of Agriculture SAGE University Bhopal (M.P.).
[2]Dean, School of Agriculture, SAGE University, Bhopal (M.P.).

Introduction

Tomato (*Solanum lycopersicum* L.), a member of the Solanaceae family, is one of the most widely cultivated vegetables in the world and plays an important role in the tomato economy. In the world, tomato covers 4.8 million ha and produces 37.60 t/ha (FAO, 2018). Talking about tomato cultivation in India, it is cultivated in 789 thousand hectares, which produces 19759 thousand metric tons (Horticulture Statistics at a Glance, 2018). Tomatoes are a rich source of amino acids, sugars, dietary fibre, minerals like calcium, phosphorus and iron, and vitamins (A, C and K). Due to its wide usage and nutritional value, there has been an increase in the demand for both fresh market and processed tomato varieties; therefore, there is a need for more production of tomato to meet the growing demand.

Several factors are responsible for the low productivity of tomato, which affects production. The most important of these factors are diseases. Among those diseases, the late blight disease *Phytophthora infestans* is the most devastating and widespread in temperate, tropical and subtropical regions of the world.

It can infect and destroy the crop at any stage of development and is capable of rapid spread resulting in complete destruction of these crops. Yield loss due to late blight in India varies from year to year and range from 20-75 % (Sundaresha *et al.*, 2015).

Symptoms of Late Blight

Phytophthora infestans can infect each part of the plant like leaf, fruits and stem. Late blight disease symptoms first appear as small, minute, water-soaked areas that rapidly enlarge to form purple-brown, oily-appearing blotches. On the lower surface of leaves, rings of grayish-brown white mycelium and spore-forming structures may appear around the blotches. Affected leaves die and infections quickly spread to petioles and young stems. Infected fruit turn brown to dark brown but remain firm unless infected by secondary decay organisms; symptoms mainly begin on the shoulders of the fruit because spores land on fruit from above.


Pathogen

Phytophthora infestans is a pathogen that comes under phylum Oomycota, class Oomycetes, order Peronosporales and family Pythiaceae (G.C.Ainsworth,1973). ***Phytophthora infestans*** was first named *Botrytis infestans* by M. J. Berkeley in the 1840's. In 1876, the pathogen was renamed by Anton de Bary to *Phytophthora infestans* (de Bary, 1876). The name is derived from the Greek: *Phyto* = plant, *phthora* = destroyer. The fungus mycellium of *Phytophthora infestans* is endophytic, with highly branched, intercellular, 4 to 8 μm in diameter. This hyphae absorbs food from the host cell by club shaped houstoria, which are present singly or in pairs in a cell. Sporangiophores develop from the mycelium and come out through stomata or lenticels of tubers. Sporangia are pear shaped and papillate and develop at the tips of sporangiophores. The sporangia germinate and form secondary sporangia which produce zoospores upon germination. The zoospores are biflagellate and cause infection to the host.

Management

For the management of the late blight different methods have been used. In this include cultural, use of resistant varieties, biological control, chemical control and disease-free planting material.

Cultural Control

Late blight of Tomato is so widespread that it is difficult to escape it completely, but several cultural practices can help. We know that the fungus overwinters in infected crop debris and can persist from one season to the next in the same field.

1. Crop Rotation: Crop rotation is one of the most effective strategies in reducing levels of late blight on tomato. Using a three- or four-year crop rotation with non-solanaceous crops will allow infested plant debris to decompose in the soil. In cultural control crop rotation, mainly help to reduce the population of the pathogens in the soil. It is effectively controlling a soil borne pathogen.

2. Mulching: Mulching is also an important cultural practice to control weeds, optimize soil moisture and keep the soil cool. Mulching helps in creating unfavorable conditions for soil borne pathogens thereby controlling the diseases easily. Mulching also prevents soil borne diseases from splashing on tomato leaves during irrigation.

3. Organic amendments: Good quality compost improves soil structure, water and nutrient holding capacity and increases water holding capacity; It also supports microorganisms that contribute to biological control. Early blight severity was lower in tomato plants grown in compost-amended soil than in non-amended soil.

Biological Control

Foliar application of fungal bio agents i.e., *Trichoderma viride* @ 0.25% and bacterial bio agent i.e., *Pseudomonas fluorescens* @ 0.25% found effective against late blight of Tomato.

Use of Plant Extract

The most effective plant extracts for minimizing the severity of the late blight disease were Garlic bulb extract, Neem leaf extract, Datura leaf extract and Onion bulb extract @ 20%.

Chemical Control

The use of chemical fungicides is considered as the most effective approach for controlling late blight. Apply fungicides as needed throughout the growing season. Several forecast techniques have been developed that predict when a spray will be necessary based on environmental conditions. Apply protective spray of Mancozeb@2 g/liter water. After appearance of the disease spray Cymoxanil 8% + Mancozeb 64% WP @ 3g/liter water or Fenamidone 10% + Mancozeb 50%WG @ 3g/liter water.have been widely used to control late blight, reducing the effect of the disease and enhances yield of tomato.

Conclusion

Tomato is one of the most economically significant vegetable crops grown and eaten globally. The disease known as early blight, which is brought on by *Phytophthora infestans*, is one of the most significant and widespread diseases of the cultivated tomato. Tomato late blight is managed by a variety of management approaches, including cultural, biological, chemical, and plant extract methods.

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Article on Drip Irrigation System

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Nalamala Sruthi[1], Dr Yadvendra Pal Singh[1]
[1]School of agriculture, Lovely professional university, Punjab.

Introduction

Drip irrigation system is a type of micro-irrigation system that is widely used around the world to improve crop yields and to increase crop yield potential. It is the most recent irrigation method to be developed. It is used as a surface and subsurface irrigation method, depending on the situation.

In surface irrigation, water is distributed to the agricultural land through small channels that flood the area to a depth determined by the amount of water required. Hydraulic applications and distribution can be accomplished either by gravity or by pumping. When used on soils with low to moderate infiltration capacities and on lands with uniform terrain, this method is effective. It is further divided into three categories: flow and lift irrigation; perennial irrigation; and flood irrigation. Farmers have traditionally used this method to harvest their crops. However, because of the significant disadvantage of this practice was found to be ineffective due to water loss due to evaporation in the middle of the process.

It is also possible to use drip irrigation in conjunction with subsurface irrigation, which is another option. Subsurface irrigation is a type of irrigation in which water flows underground and nourishes plant roots through capillary action. Water is delivered directly to the roots, with no excess water flowing anywhere else in the system. The network is made up of three types of pipes: main pipe, sub main pipe, and lateral perforated pipe. This method is best suited for soils with high water permeability. They can be further divided into two categories: natural sub irrigations and artificial sub irrigations. Artificial irrigation, on the other hand, is more expensive and is therefore only recommended in areas with high returns.

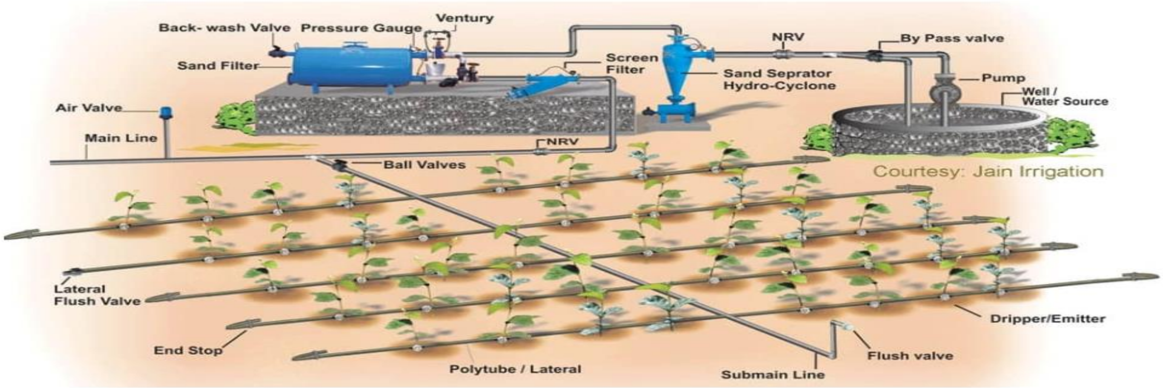
Methodology

Drip irrigation is a technique in which water and fertilizer are applied slowly and directly to the root zone of the plant in order to reduce evaporation and seepage losses. This is accomplished through the use of specially designed emitters and drippers. This method is best suited for row crops and orchards, such as tomatoes, grapes, corn, cauliflower, cabbage, and other similar crops, as well as orchards.

Using drip irrigation has a number of advantages, including the fact that it requires little water, has low evaporation losses, produces the fastest rate of vegetative growth, wets the soil surface the least amount of time, and thus reduces the occurrence of diseases caused by damp conditions. There is no need to level the land. There is no soil erosion taking place. There is less labour required. One example is Israel, which was experiencing severe water shortages prior to the implementation of drip irrigation. After implementing drip irrigation, Israel's water supply was significantly improved. And the disadvantages include a lot many too. It is little expensive, around 30 – 40k per acre or may vary through states/ locality with subsidies imposed on them. Requires extra training apart from notion of general farming. Government is doing its best to raise awareness through camps or books on this newly adopted system. Have to redo, good qualities pipes have general life span of 5 years, which may be exceeded maximum to 8 years. After which, the entire pipe system needs to be removed and changed with the new pipes. This is tedious and time taking. Does not offer frost protection. Needs regular flushing and supervision. High skill is required in the design, installation, operation and maintenance.

Drip irrigation system is not traditionally irrigation; therefore, farmers need to learn the technique which takes little training (now also provided by government camps and education). Water is saved by minimizing evaporation. Low soil erosion occurs. The main benefit of drip irrigation system is that water is directly at the root zone. Surface drip or surface. Cheap pipes made in possible. Subsidies can be given by the government for installation of drip system. Proper guidelines are given for its entire set – up this is for outlet system.

It saves up to 20 to 50% of water, therefore saving fertilizers like nitrogen gas which are directly sent to the pipes, saving up electricity charges and also recharges the rainwater. Nowadays, new techniques used to resist the rodent incubation involves setting the pipes' plastic layer with posion, so that when any rodent bites it, gets poisoned and dies on spot.



Disadvantages of Drip Irrigation System

1. The initial cost can be more than other irrigation systems.
2. The sun can influence the pipes utilized for the trickle water system, shortening their life.
3. The PVC pipes regularly experience rat harm's ill effects, requiring substitution of the whole pipe and expanding costs.
4. In lighter soils, the subsurface drip system might not wet the dirt surface for germination.
5. The opening can get easily blocked.

Conclusions

1. Farmers with less income or small farmers who are marginalized have less tendency to obtain drip irrigation systems in any form. The major reason for it is the high initial costs and short lifespan of pipes in this system. Also, since most of these small farmers do not have large enough land holdings, therefore investing in drip irrigation techniques becomes not viable for them.

2. It may also be concluded that big farmers having large landholdings are more willing to acquire this technique as it saves them to labour, water, electricity, and fertilizer costs. It optimizes available water for them as evaporation loss is less and water is dripping directly at the root of the plant.

3. Although, for a country like India, drip irrigation is very beneficial and must be adopted. However, when the matter of the world is concerned, it has its own complications. Some countries like New Mexico which face deficit irrigation develop stresses in plants thereby making the crop more prone to diseases and attacks causing environmental harm. For such areas, this technique takes a dip as the crop yields are reduced as water never reaches the water deficit areas. For many such places as such, water-saving techniques are used which may reduce the downstream flow of water and raise production.

4. Drip irrigation was found to be better than most of the other irrigation methods due to its multiple advantages and adaptability in the current scenario in the irrigation system. It is simple and needs little training to implement. The government in many states also promoted the procurement of the same by providing subsidies.

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Integrated Pest Management of Fall Army Worm in Maize

Article ID: 40618

Sonali Nakambam[1], Debanand Biswas[2]

[1]Department of Entomology, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar.

[2]Department of Entomology, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar.

Fall armyworm (*Spodoptera frugiperda* J.E. Smith) is one of the most destructive invasive pests of maize crop. It is native to Americas and is known as a pest in the United States since 1797. It invaded Africa in 2016, where in a span of two years it has spread to 44 countries. The incidence of FAW in India was first observed in Shivamogga district of Karnataka on 18th May, 2018 reported by University of Agriculture and Horticulture sciences, Shivamogga.

Damage Symptoms

FAW attacks all crop stages of maize from seedling emergence to ear development. First and second instar larvae of FAW feed on the opened leaves by scraping and skeletonising the upper epidermis leaving a silvery transparent membrane resulting into papery spots. The damage by third instar results in shot hole symptoms on the leaves. lts in extensive defoliation of leaves and presence of large amounts of faecal pellets in whorls. If infestation continues during reproductive stage, it may damage tassels or may bore inside the developing ear and eat away the grain. The whorl damage by fall army worm result in significant yield losses while ear feeding results in both quality and yield reduction.

Integrated Management

Crop management practices along with systematic plant protection in an area wide manner can manage FAW population below economically damaging levels. An integrated pest management (IPM) approach is to be followed as described below:

Pre-planting practices:

a. Deep plough the fields to expose pupae to sun light and predatory birds.

b. Add neem cake @ 200kg/acre to the fields when maize is grown with zero tillage or wherever possible.

c. Maintain field bunds clean and plant flowering plants such as marigold, sesame, niger, sunflower, coriander, fennel etc. to attract natural enemies.

Sowing to six leaf stage:

a. Timely and uniform sowing over larger area.

b. Follow ridge and furrow planting method instead of flatbed sowing.

c. Apply only the recommended dosage of NPK as basal dose.

d. Seed treatment: Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg of seed offers protection for 15-20 days of crop growth.

e. Plant 3-4 rows of napier grass/hybrid napier as trap crop around maize fields. Intercrop maize with legumes viz., pigeonpea, cowpea, black gram, kidney bean etc. in 2:1 to 4:1 ratio.

f. Erect bird perches @10/acre to encourage natural FAW predation by birds.

g. Install pheromone traps @ 4/acre soon after sowing and monitor moth catches. Adopt clean cultivation to eliminate possible alternate hosts.

h. Destruction of egg masses and larvae by crushing.

i. Application of sand or soil mixed with lime in 9:1 ratio into whorl of maize plants. First spray should be with 5% neem seed kernel extract (NSKE) or azadiractin, 1500 ppm (1 litre/acre) @ 5ml /litre after observation of one moth/trap/day or 5% FAW infestation on trap crop or main crop

j. Release egg parasitoids *viz.*, *Telenomus remus* @ 4000/ acre or *Trichogramma pretiosum* @ 16,000/ acre. k. Two releases of parasitoids at weekly interval should be done.

Seven leaf stage to flowering:

a. Monitoring of FAW using pheromone traps @ 4/acre should be continued.

b. Spray 5% NSKE or azadiractin, 1500 ppm (one litre/acre) @5 ml /l after observation of one moth/ trap/day or 5% of fresh FAW infestation.

c. If infestation is more than 10%, whorl application of *Bacillus thuringiensis* formulations (4litres/ acre) @ 20ml/litre or *Metarhizium anisopliae* or *Beauveria bassiana* (1×108 cfu/g) (1 kg/acre) @ 5g/litre or SpfrNPV (800 ml/acre) @4ml/litre (1.5X1012 POBs/ha) or Entomopathogenic nematode (*Heterorhabditis indica*) (4kg/acre) @20g/litre of water is recommended.

d. If infestation is more than 20%, whorl application of any one of the recommended insecticides for FAW, *viz*., Chlorantraniliprole 18.5 SC (80 ml/acre) @ 0.4 ml/litre; Thiamethoxam 12.6 % + Lambda cyhalothrin 9.5% ZC (50ml/acre) @ 0.25 ml/litre; Spinetoram 11.7 % SC (100ml/acre) @ 0.5 ml/litre; Emamectin benzoate 5% SG (80g/acre) @ 0.4g/litre is recommended.

Flowering to harvest:

a. Hand picking and destruction of larvae boring into ears. At 10% ear damage, whorl application of *Bacillus thuringiensis* formulations (4litres/acre) @ 20ml/ litre or *Metarhizium anisopliae* or *Beauveria bassiana* (1×108 cfu/g) (1 kg/acre) @ 5g/litre or SpfrNPV (800 ml/acre) @4ml/litre (1.5X1012 POBs/ha)

b. Installation of Pheromone traps– Funnel trap with FAW lure should be installed at a height adjusted each week matching with crop canopy.

c. Application of Neem Seed Kernel Extract (NSKE).

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Drones in Indian Agriculture

Article ID: 40619

Malini Sri M[1], Deepa S[2], Rajasekar G[3]
[1,2]UG Scholar, Adhiyamaan College of Agriculture and Research, Athimugam, Krishnagiri, Tamil Nadu, India.
[3]Assistant Professor, Plant Pathology, Adhiyamaan College of Agriculture and Research, Athimugam, Athimugam, Krishnagiri, Tamil Nadu, India.

Introduction

Drones are becoming increasingly popular in agriculture because they can provide farmers with valuable information about their crops and land. Research and farmer adoption of new technologies have aided in the rapid advancement of Indian agriculture. In India, robotic farming for planting, harvesting, and grading as well as drip irrigation technology are being employed successfully for sustainable agriculture. Drone use in agriculture has grown in popularity recently, and certain states are actively investigating if this new technology is appropriate for Indian agriculture. Drone-assisted pesticide application has a lot of potential as we work to commercialize agriculture and increase crop accuracy. Drones will be crucial for improving the efficacy of applying crop protection chemicals by decreasing the need for human labour, application time, water consumption, chemical quantity, and environmental drift, as well as lowering human exposure to dangerous chemicals.

Some of the sensors commonly used in agricultural drones include:

1. RGB cameras: These cameras capture high-resolution images of crops, which can be used to identify plant stress, growth patterns, and overall health.

2. Multispectral cameras: These cameras capture images in multiple spectral bands, allowing farmers to monitor plant health, detect early signs of disease, and optimize crop yields.

3. Thermal cameras: These cameras capture heat signatures, allowing farmers to identify areas of the field that are too hot or too cold. This information can be used to adjust irrigation or identify pest infestations.

4. LiDAR sensors: These sensors use laser technology to create 3D maps of fields, allowing farmers to identify topography, track crop growth, and detect changes in soil elevation.

Why do we Need Drones in Agriculture?

Drone technology in agriculture involves the use of unmanned aerial vehicles (UAVs) to collect data and perform tasks related to farming. Here are some ways that drone technology works in agriculture:

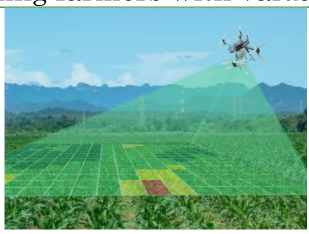
1. Crop mapping and monitoring: Drones equipped with high-resolution cameras and sensors can create accurate maps of farms and monitor crop health. This allows farmers to identify areas of their fields that require more attention and adjust irrigation, fertilization, or pesticide application as needed.

2. Planting and seeding: Some drones are designed to plant and seed crops with precision, delivering seeds or fertilizer directly to the soil at optimal depths and spacing. This can save farmers time and money while also improving crop yields.

3. Crop spraying: Drones can also be used to spray crops with pesticides or herbicides, which can be more efficient and precise than traditional spraying methods. Drones can cover larger areas in less time, reduce chemical usage, and minimize exposure risks for farmers.

4. Livestock monitoring: Drones equipped with thermal imaging cameras can be used to monitor the health and behavior of livestock, such as identifying sick or injured animals and tracking their movements.

5. Soil and water analysis: Drones can collect data on soil moisture, nutrient levels, and water quality, providing farmers with valuable information for crop management and environmental sustainability.


Crop Monitoring

Planting and seeding


Crop spraying


Livestock Monitoring


Soil and Water analysis

Benefits of Drones in Agriculture

1. Precision agriculture: Drones can be equipped with various sensors, such as multispectral and thermal cameras, that can collect high-resolution data on crop health, soil moisture, and other variables. This data can then be used to create detailed maps and analyses, enabling farmers to apply inputs more precisely, optimize crop yields, and reduce waste.

2. Increased efficiency: Drones can cover large areas of farmland quickly and easily, without the need for human labor or expensive equipment. This can save farmers time and money and increase their productivity.

3. Cost-effectiveness: Drones are becoming more affordable and accessible, making them a cost-effective solution for many farmers. They can be used for a variety of tasks, such as crop scouting, planting, and spraying, which can reduce the need for expensive equipment and labor.

4. Safety: Drones can be used to inspect crops and infrastructure, such as irrigation systems and buildings, without putting workers at risk. This can improve safety on the farm and reduce the likelihood of accidents.

5. Environmental benefits: Drones can be used to apply inputs, such as fertilizer and pesticides, more precisely and efficiently, reducing the amount of chemicals needed and minimizing the impact on the environment.

Limitations of Drones in Agriculture

While drones offer many advantages for agriculture, there are also several limitations that need to be considered. Here are some of the limitations of using drones in agriculture:

1. Limited battery life and range: Drones have limited battery life and range, which can limit their effectiveness in large-scale farming operations. They may need to be recharged or refueled frequently, which can cause downtime and reduce efficiency.

2. Weather conditions: Drones are sensitive to weather conditions such as wind, rain, and fog. They may not be able to fly in certain weather conditions, which can limit their usefulness in agriculture.

3. Limited payload capacity: Drones have limited payload capacity, which can limit their ability to carry heavy equipment or large quantities of inputs, such as fertilizer or pesticide. This can make them less effective for some agricultural tasks.

4. Regulatory restrictions: Drones are subject to regulatory restrictions that may limit their use in certain areas or for certain tasks. For example, in some countries, drones may be prohibited from flying overpopulated areas or beyond the operator's line of sight.

5. Technical skills: Operating a drone requires technical skills and knowledge, which can be a barrier for some farmers. They may need to invest time and resources in training their staff or outsourcing drone-related tasks to a third-party service provider.

Conclusion

Drones have already dramatically impacted on the agricultural economy and will continue to grow in the coming years. While drone use is becoming more valuable to small farmers, there is still a way to go before they become part of every farmer’s equipment roster, particularly in developing nations. In many nations, laws governing drone use need to be created or changed, and more study is needed to determine how successful they are at carrying out certain activities like applying and spraying pesticides. Drones can be valuable to farmers in a variety of ways, but before purchasing pricey equipment, it is crucial to understand their capabilities and limitations.

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Time Temperature Indicator and its Application in Food Packaging

Article ID: 40620

Prakasha R[1], Pathiam Srilatha[2]

[1]M. Tech. Scholar, Food Processing Technology, College of Food Processing Technology and Bio Energy, Anand Agricultural University, Anand, Gujarat.

[2]Pathiam Srilatha, Assistant Professor, Department of Food Processing Technology, College of Food Science & Technology, Professor Jayashankar Telangana State Agricultural University, Rudrur, Nizamabad, Telangana.

Introduction

The quality and safety of food items throughout both distribution and storage are greatly impacted by temperature, which is one of the key elements. It is challenging to maintain control over and keep track of the temperature history of food items in order to accurately estimate shelf life. Using time-temperature indicators (TTIs), you can visually summarize the entire history of the chill chain of a product, and also it is possible to estimate how much temperature has changed over a certain period of time affecting a food product's full or partial temperature history. The operating principles of TTI are based on irreversible changes caused by microbiological, enzymatic, polymer, photochromic, or diffusion-based processes. These changes produce an irreversible color shift, which is often displayed as a visible reaction in the label. Based on the visible response, duration and temperature can be determined cumulatively by watching the rate of change in the system.

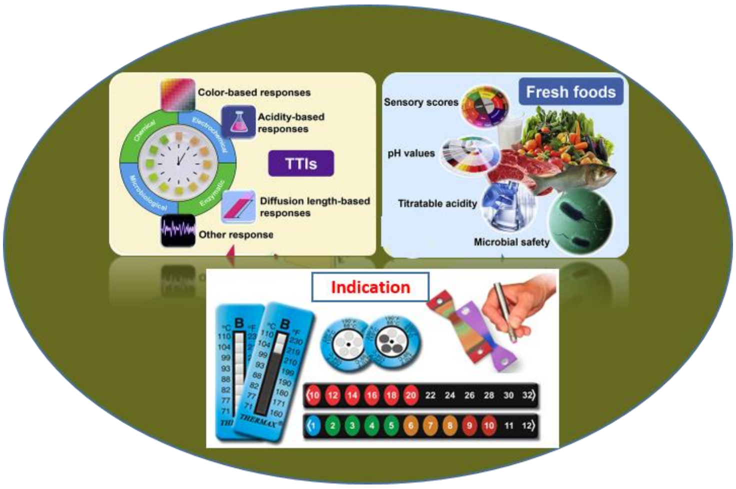

Fig 1: Different types of TTI responses and indication with the fresh foods

Characteristics

1. It should be simple, inexpensive, effective, and simple to integrate into packaging.
2. It shouldn't shorten a product's shelf life by subjecting it to mechanical forces or environmental conditions.
3. It should offer all target groups precise, reliable, and understandable information.
4. It shouldn't negatively impact the environment or human health.

Advantages

1. It gives information on temperature and variation history in temperature, especially in the case of products transported under refrigerated or frozen conditions
2. The supply chain should be integrated with the cumulative time-temperature history of the package
3. Intended to monitor any detrimental changes in temperature change (above or below reference critical value).

Current TTI Systems

1. Microbial TTIs: These TTIs are regarded as the most sophisticated because of how they react when food is spoiled by microorganisms. It is evidence that bacteria are proliferating and metabolizing within the TTI system (Mataragas et al., 2019). For applications in the food business, such as tracking foodstuffs in supermarkets and prepared meals and sandwiches in the catering industry, (eO)® and TRACEO® are acceptable. It may also be applied to the healthcare sector to track blood collection bags, vaccinations, and other things.

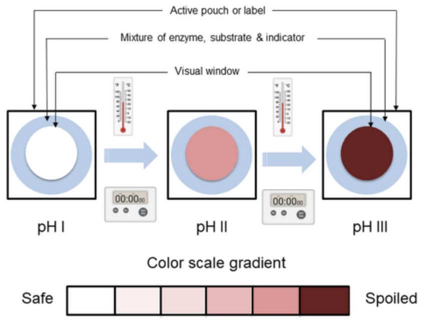

Fig 2: Indication of enzymatic TTI

2. Enzymatic TTIs: These indicators work by using a regulated enzymatic hydrolysis of a lipid substrate to cause a pH-dependent color shift. The TTI is divided into two separate, airtight chambers, one of which holds a mixture of an aqueous lipolytic enzyme solution and a pH-indicating dye. The other compartment contains the lipid substrate (glycerin, tricapronate, organic acids, etc.) absorbed in a pulverized PVC carrier and suspended in an aqueous medium. TTI is activated by pressing on the plastic, which results in the mixing of the enzyme and substrate. After the ensuing reaction encourages substrate breakdown, fatty acids are released. Due to the pH dropping as a result, the pH indicator's hue has changed from deep green to brilliant yellow or orange-red (Wu et al., 2019).

3. Polymer-based TTIs: It is a tiny, low-cost, self-adhesive label used to keep track of the shelf life of perishable goods. It is made up of an exterior reference ring around a specifically created polymer core that is time- and temperature-sensitive. When the product reaches a certain threshold temperature, a dot progressively and irreversibly darkens. Temperature-dependent color changes occur more quickly at higher temperatures while taking longer at lower temperatures. A portable colorimeter or an optical densitometer can be used to continually measure the color-changing dot in the active center of the indicator while comparing it to the reference ring. Freshness of the product is shown until the central dot turns darker than the outside ring (Moustafa et al., 2019).

4. Photochromic TTIs: It is a non-toxic printed time-temperature indicator that relies on the characteristics of photochromic colorants (dyes or pigments), which alter their color over time in response to temperature changes. A reference color is present as a ring around the photochromic area on the label or printed display (Gao et al., 2020).

5. Diffusion-based TTIs: It works by using a colored fatty acid ester's time-temperature-dependent diffusion via a porous wick indicator track strip made of premium blotting paper. Ex: 3M Monitor MarkTM indicator, Tempix®, and Timestrip®.

Fig 3: Commercial Timestrip® which showing the colour changes from white to blue

Commercial Application of TTI

Pasteurized whole milk, cottage cheese, chilled lettuce and tomatoes, frozen hamburger, refrigerated ready-to-eat salads, frozen bologna, refrigerated orange juice, chilled cod fillets, frozen strawberries, pasteurized cream, UHT milk, and chilled fresh salmon.

Conclusion

As perishable food products are prepared, packaged, transported to shops, and sold at retail, a time-temperature indicator plays a crucial role in the supply chain. They are able to give individuals helpful knowledge regarding food quality throughout the food supply chain. It is possible to increase shelf-life and food safety by correctly using the active or intelligent packaging. In order to develop and implement this type of packaging, industry and consumers must accept it and realize its cost-effectiveness.

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Anabaena Variabilis -A Photosynthetic Cyanobacteria

Article ID: 40621

Charukeshini R[1], Monika R[2], Rajasekar G[3]

[1,2]UG Scholar, Adhiyamaan College of Agriculture and Research, Athimugam, Krishnagiri, Tamil Nadu, India.

[3]Assistant Professor, Plant Pathology, Adhiyamaan College of Agriculture and Research, Athimugam, Athimugam, Krishnagiri, Tamil Nadu, India.

Introduction

Anabaena variabilis is a species of cyanobacteria, a group of photosynthetic bacteria that can produce oxygen through photosynthesis. It belongs to the order *Nostocales*. It is a photosynthetic organism capable of fixing atmospheric nitrogen through a process called diazotrophy. It has several potential benefits for agriculture. Here are some ways in which *Anabaena variabilis* can be important in agriculture:

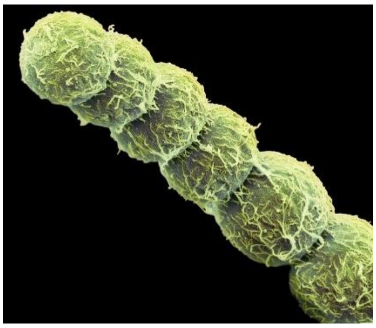
1. Nitrogen fixation: Anabaena variabilis is capable of fixing atmospheric nitrogen, which means that it can convert atmospheric nitrogen into a form that can be used by plants. This ability makes Anabaena variabilis an important player in the nitrogen cycle, particularly in agricultural soils that may be deficient in nitrogen.

2. Biofertilizer: Anabaena variabilis has been used as a biofertilizer in agricultural settings. It can be applied to soil to increase the availability of nitrogen to plants, which can result in increased crop yields.

3. Soil improvement: Anabaena variabilis can also improve soil structure and water-holding capacity, which can benefit plant growth and health.

4. Environmental sustainability: The use of Anabaena variabilis as a biofertilizer can reduce the need for synthetic fertilizers, which can have negative environmental impacts, such as eutrophication of waterways.

5. Bioremediation: Anabaena variabilis has also been studied for its potential use in bioremediation of contaminated soils. It has been shown to have the ability to degrade pollutants such as polycyclic aromatic hydrocarbons.



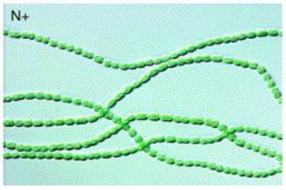
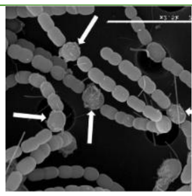
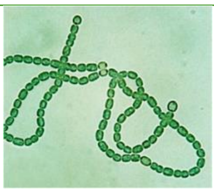
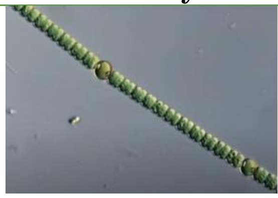
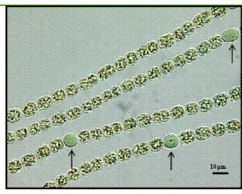
Structure of *A. variabilis*

Anabaena variabilis is a filamentous cyanobacterium that has a complex, multicellular structure with several distinct structural parts. Here are some of the main parts of Anabaena variabilis:

Filament: The filament is the basic structural unit of Anabaena variabilis and consists of a chain of individual cells that are connected end-to-end. The filament can range in length from a few millimeters to several centimeters.

Heterocyst: Heterocysts are specialized cells that are involved in nitrogen fixation. They have a thick, impermeable cell wall that prevents oxygen from entering, which is necessary for the functioning of nitrogenase, the enzyme complex that catalyzes nitrogen fixation. Heterocysts are spaced at regular intervals along the filament.

Akinete: Akinetes are specialized cells that are involved in reproduction and survival under adverse environmental conditions. They are thick-walled and can withstand desiccation and other stresses. Akinetes are often found at the ends of filaments.

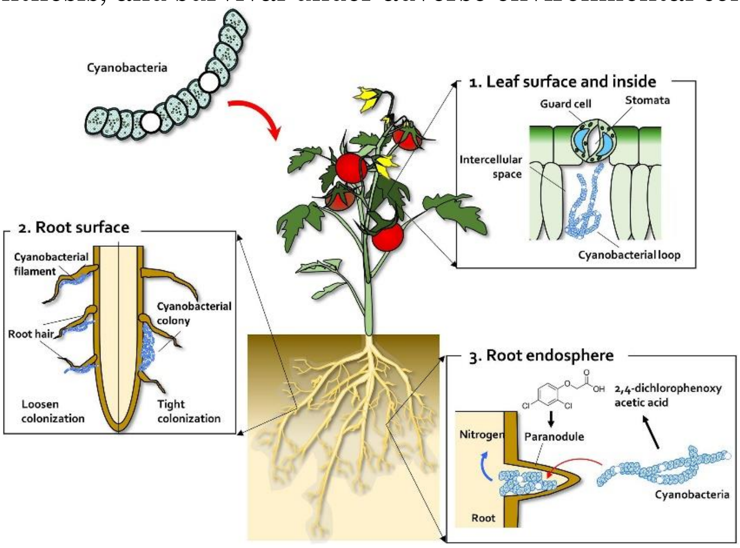
 Filament	 Heterocyst	 Akinete
 Vegetative cells	 Sheath	 Gas vesicles

Vegetative cells: Vegetative cells are the photosynthetic cells of Anabaena variabilis. They carry out oxygenic photosynthesis and provide the heterocysts with the necessary energy and carbon sources for nitrogen fixation. Vegetative cells are smaller than heterocysts and are interspersed between them along the filament.

Sheath: The sheath is a mucilaginous layer that surrounds the filament of Anabaena variabilis. It provides mechanical support and protection from external stresses, and also plays a role in the exchange of nutrients and metabolites between cells.

Gas vesicles: Gas vesicles are small, hollow structures that are found within the cells of Anabaena variabilis. They provide buoyancy to the cells, allowing them to float towards the surface of the water to access light and nutrients.

Overall, the complex structure of Anabaena variabilis allows it to carry out a range of functions, including nitrogen fixation, photosynthesis, and survival under adverse environmental conditions.



Benefits

1. Nitrogen fixation: Anabaena variabilis is capable of fixing atmospheric nitrogen, which can reduce the need for synthetic nitrogen fertilizers that are energy-intensive to produce and can have negative environmental impacts.

2. Sustainable agriculture: The use of Anabaena variabilis as a nitrogen fertilizer can contribute to sustainable agriculture practices by reducing the use of synthetic fertilizers and improving soil health.

3. Low-cost production: Anabaena variabilis can be produced at a low cost using simple culture techniques, which can make it an attractive option for small-scale farmers.

Limitations

1. Environmental factors: Anabaena variabilis requires specific environmental conditions, such as warm temperatures, sufficient light, and high pH, which may limit its use in some regions.

2. Variable nitrogen fixation rates: The nitrogen fixation rates of Anabaena variabilis can vary depending on environmental conditions, which may make it difficult to predict its effectiveness as a fertilizer.

3. Regulation: The use of Anabaena variabilis as a fertilizer may be subject to regulatory requirements, which can add additional costs and barriers to its adoption.

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Organic Farming: As a Key for Sustainable Agricultural Development

Article ID: 40622

Yumnam Sanatombi Devi[1], Tabuiliu Abonmal[2], Thoudam Anupama Devi[2]
[1]South Asian Institute of Rural and Agricultural Management, Imphal West.
[2]College of Agriculture, CAU, Imphal.

Introduction

The world's population has increased to touch approximately 11 billion (United Nations, 17 June 2019). As a result, to keep up with the expanding population demand, food production must be increased. Apart from meeting food needs, the agriculture sector also contributes to the country's economic development. Conventional farming is the most commonly followed practice, but it makes use of synthetic fertilizers for growing crops and pesticides for killing weeds. These synthetic additives are detrimental to soil productivity, pollute water resources, and are harmful to human health.

Gupta et al. (2021) recognized a total of 30 sustainable agricultural approaches (SAPs) in India. Organic farming is one such vital SAP for addressing India's current agriculture.

Organic farming is a production system that avoids or largely excludes the uses of synthetically compounded fertilizers, pesticides, growth regulations, genetically modified organisms, and livestock food additives. To the maximum extent, possible organic farming systems rely upon crop rotations, the use of crop residues, animal manures, legumes, green manures, off-farm organic wastes, biofertilizers, mechanical cultivation, mineral-bearing rocks and aspects of biological control to maintain soil productivity and tilth to supply plant nutrients and to control insect, weeds and other pests.

Organic methods can increase farm productivity, repair decades of environmental damage, and knit small farm families into more sustainable distribution networks leading to improves food security if they organize themselves in production, certification, and marketing. During the last few years, an increasing number of farmers have shown a lack of interest in farming and the people who used to cultivate are migrating to other areas. Organic farming is one way to promote either self-sufficiency or food security. The use of massive inputs of chemical fertilizers and toxic pesticides poisons the land and water heavily. The after-effects of this cause loss of topsoil, decrease in soil fertility, surface and groundwater contamination, and loss of genetic diversity.

Major principles of organic farming defined by the International Federation of Organic Agriculture Movements (IFOAM) are principles of health, care, ecology, and fairness (I.F.O.A.M., 2005a). The soil fertility is largely maintained by using organic manures, following crop rotation, and planting cover crops. Pest diseases and weeds are managed via physical and biological control systems. Organic livestock is reared without the application of antibiotics and growth hormones. They are also given routine immunization, vitamins, and minerals supplementation (Roychowdhury et al., 2013; Patil et al., 2014; Das et al., 2020).

Importance of Organic Farming in the Present Scenario

The green revolution fulfilled our aspirations by changing India from a food importing to a food exporting nation which involved greater use of synthetic agrochemicals such as fertilizers and pesticides with the adoption of nutrient-responsive, high-yielding varieties of crops. However, the achievement was at the expense of soil health and the environment and to the harm of the well-being of the people. Hence, a natural balance needs to be maintained at all costs without affecting the soil health as well as getting higher crop yields and quality of products for an ever-increasing population. Thus, organic farming is a potential alternative to conventional agriculture which avoids or largely excludes the use of synthetic inputs such as fertilizers, pesticides, hormones, feed additives, etc, and to the maximum extent depends upon crop rotations, crop residues, animal manure, off-farm organic waste, mineral grade rock additives and biological system of nutrient mobilization and plant protection.

In the present agricultural scenario, crop yield is declining day by day despite the maximization of chemical inputs. The cycle of chemical farming is now exposed to increasing crop unsustainability, higher input requirement, poor soil quality as well as recurrent pest and disease infestation. Moreover, in the pretext of climate change yield interference has become quite predictable under unpredictable weather conditions vis-à-vis the hike in biotic potential.

The excess/ indiscriminate use of pesticides and fertilizers has led to the entry of harmful compounds into the food chain, the death of natural enemies, and the deterioration of the surrounding ecology. Enhanced use of pesticides has resulted in serious health implications for man and his environment. Hence, the enhancement and maintenance of system productivity and resource quality are essential for sustainable agriculture.

Organic farming can solve many of these problems as this system helps to maintain soil productivity and effectively control pests by enhancing natural processes and cycles in harmony with the environment. Today, it is clear that organic farming is the best option for not only protecting/sustaining soil plant-ecological relationships but to mitigate the adverse effect of climate change.

Concept of Sustainable Development

Sustainable development is defined as development in a direction that the present generation's needs are met without overexploitation of resources so that future generations' needs are not compromised. The objective of sustainable development of agriculture is "to increase food and enhance food security in an environmentally sound way to contribute to sustainable natural resource management, as outlined in a decision of the Commission on Sustainable Development. Sustainable agriculture is a productive, competitive, and efficient way to produce safe agricultural products, while at the same time protecting and improving the natural environment and social/economic conditions of local communities. Sustainable agricultural management practices include soil and water conservation to prevent degradation of soil productivity, efficient use of limited irrigation water without leading to problems of soil salinity, alkalinity, and high ground water table, crop rotations that mitigate weed, disease and insect problems, increase soil productivity and minimize soil erosion, integrated nutrient management that reduces the need for chemical fertilizers improves the soil health and minimize environmental pollution by conjunctive use of organics, in-organics, and bio-fertilizers, integrated pest management that reduces the need for agrochemicals by crop rotation, weather monitoring, and use of resistant cultivar, planting time and biological pest control and management system to control weed by preventive measures, tillage, timely inter cultivation and crop rotation to improve plant health. Increasing consciousness about sustainable agriculture and health risks associated with agrochemicals has brought a major shift in people's preference for safe and high-quality food. This has led to a growing interest in alternative farm practices, including organic agriculture. Organic farming can be an absolute path to socio-economic and ecologically sustainable development, especially in developing countries (Gilbert et al., 1990).

Conclusion

Agriculture is the main source of livelihood in India and accounts for 20-30% of each household income (Qiao et al., 2015). The phenomenon of "Organic agriculture" is the only solution to the nature of the land and to regenerate the soil by going back to our traditional method of farming i.e., free from chemicals pesticides and fertilizers. There is a real need to go forwards with organic farming to maintain plant, environment, and human health. Organic farming yields more nutritious and safe food. Organic food is also a better choice for the environment as well. These products are the best from nature. The organic farming process is more eco-friendly than conventional farming. Organic agriculture promotes the health of consumers a nation, the ecological health of the nation, and the economic growth of a nation by income generation holistically. India, at present, is the world's largest organic producer (Willer and Lernord, 2019) and with this vision, we can conclude that encouraging organic farming in India can build a nutritionally ecological and economically healthy nation in near future.

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Biosensors: A Breakthrough Technology

Article ID: 40623

Nairita Vaidya[1], Karishma Behera[2]
[1]Department of Molecular Biology and Biotechnology,
[2]Department of Plant Breeding and Genetics,
Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur-482004.

Abstract

Biosensor is an important device that finds its applications in many fields such as in healthcare involving disease diagnosis and treatment, environmental monitoring, food quality and agriculture. A biosensor combines a particular biological element with a transducer where the bioelement identifies the analyte and undergoes reactions that is converted to electric signal by transducer. A biosensor employs various bioelements on basis of the analyte present. It can also be classified on the basis of transducing elements. This article focuses on principle and mechanism underlying the biosensors, types of biosensors and various applications of the biosensor.

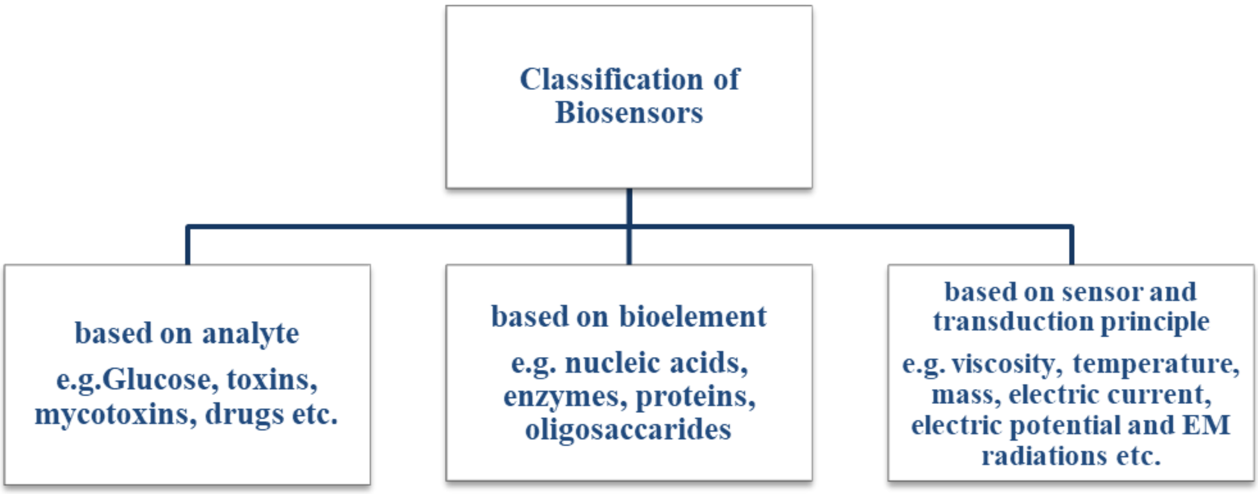
Introduction

The application of biosensor is prevalent in health care sector, drug improvement, agriculture, monitoring food as well as water quality, measurement of metabolites and toxins, monitoring soil quality and processing in different industries. A biosensor is an apparatus that employs distinct biochemical reactions carried out by isolated enzymes, immune system, tissues, organelles or whole cell to detect chemical compounds by producing signals proportional to the concentration of an analyte in the reaction (D'Souza, 2001 and Bhalla et al; 2016). A biosensor has to provide accurate results, produce a real-time assay, should be sensitive and selectively detect specific analyte in a mixture. It should be reproducible, robust and have a good resolution for detection of wide range of analytes.

Principle Underlying the Biosensors

A biosensor comprises of a biological element and a sensor element which can be immobilized by electropolymerisation, sol-gel process, microencapsulation, membrane entrapment, physical adsorption, matrix entrapment and covalent bonding. Bioelement is an organic substance employed for detecting any specific analyte. Binding of analyte to biological material produces the electric response that can be measured. The analyte may get converted to a product associated with the release of heat, gas, electrons or hydrogen ions which is converted into electric signals by transducer and amplified and measured.

Biosensors are classified according to the principle underlying the transduction mechanism, the ligands used and the analytes detected (Ali et al., 2016).



Types of Biosensors

Optical biosensors: it combines biological elements with an optical transducing system and works on the principle of absorption, fluorescence and light scattering. The bioelements undergo reactions that cause change in fluorescence or absorption due to difference in refractive index of the surface between two media differing in density. Different types of optical biosensors are surface Plasmon resonance biosensors, evanescent wave fluorescence biosensors, bioluminescent optical fibre biosensors, surface-enhanced Raman scattering biosensors and interferometric, ellipsometric and reflectometric interference spectroscopy-based biosensors (Damborsky et al; 2016)

Calometric biosensors: Enzyme catalyzed reactions release heat which is measured by the calometric biosensors. The amount of heat released is used to determine the analyte concentration.

Electrochemical biosensors: these biosensors measure ions or electrons consumed or produced in a chemical reaction occurring between immobilized receptors and target analyte. On basis of transducers, they are of three types, amperometric, potentiometric and impedimetric biosensors (Thakur et al., 2013).

Piezoelectric biosensors: they combine bioreceptors with a quartz-crystal coated with gold electrodes (piezoelectric component). They measure the resonant frequency which is produced by an oscillating crystal which helps in calculation of mass of the analyte (Pohanaka, 2017).

Applications of Biosensors

Biosensors are a pioneering technique with immense importance in health care sector especially in diagnosis of important diseases. The most commonly used biosensor is a glucose biosensor used in detection of diabetes mellitus. Estimation of cholesterol level in blood to prevent development of hypercholesterolemia and detection of cancers are other significant applications of biosensors. Other areas utilizing biosensors are food quality where it is employed for detection of *E.coli* in vegetables. It is also used in detection of food additives such as artificial sweetners (Mehrotra, 2016). In the field of agriculture and environment, biosensors are used to detect crop based diseases, test quality of fruits by determining its pH, presence of herbicides and also compute levels of pesticides, heavy metals and other pollutants in soil (Jeevula et al., 2021). Two bacterial biosensors *Enterobacter cloacae* and *E.coli* detects quantity of nitrate in the soil (DeAngelis et al., 2005).

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Biofilm: Major Threat to Dairy Industry

Article ID: 40624

Chetan C. Chougale[1], Pranjali B. Meshram[1], Abasaheb K. Parade[1]
[1]Ph.D Research Scholar, Department of Animal Husbandry and Dairy Science, Mahatma Phule Krishi Vidyapeeth Rahuri-413722, Ahmednagar (MH).

Introduction

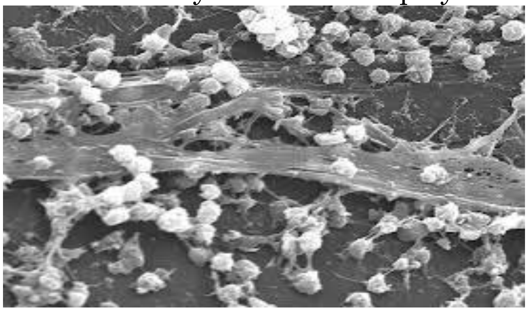
According to the changing scenario of global market, the dairy industry is considered to be one of the major food industries in world which manufactures a wide range of perishable (e.g., butter, yoghurt and cheese) and semi perishable (milk powder, casein) milk products. Insufficient sanitization and cleaning causes contaminants to accumulate in milk processing equipment which subsequently form biofilm that further become significant source of contamination of dairy products. Biofilm is aggregations of microbial cells interconnected by extracellular polymeric substances which accelerate growth on different material surfaces adversely affect the dairy industry.

What is Biofilm?

Biofilms are three dimensional aggregations of microorganisms attached to surfaces. Bacteria in the biofilm join together and form a protective matrix around each other. It is estimated that up to 90% of microbial populations exist as biofilms, rather than as discrete organisms (planktonic cells) floating around in the environment.

or

Biofilms are sessile microbial communities where microbes live together in association with each other on biotic or abiotic substrates which are bounded by extracellular polysaccharides, proteins, lipids and DNA.



Why Microorganisms Prefer to Exist in Biofilm?

Biofilm gets advantage: Get protected from environmental stresses such as extreme pH, oxygen, osmotic shock, heat, freezing, UV radiation, predators. Extracellular polymeric matrix formed from the secreted exopolysaccharides (EPS) increases the binding of water resulting in decreased chance of dehydration (desiccation) of the bacterial cells, which is a common stress condition experienced by planktonic cells. The adherent nature of microbial cells in biofilms allows rapid exchange of nutrients, metabolites, and genetic material.

Biofilm locations:

1. Dairy processing plants
2. Food and beverage plant products line
3. Water system
4. Pharmaceuticals manufacturing processes
5. Raw materials suppliers' processes
6. Cleaning chemicals
7. Steam lines
8. Cosmetics and nutraceuticals plants
9. Heat exchangers.

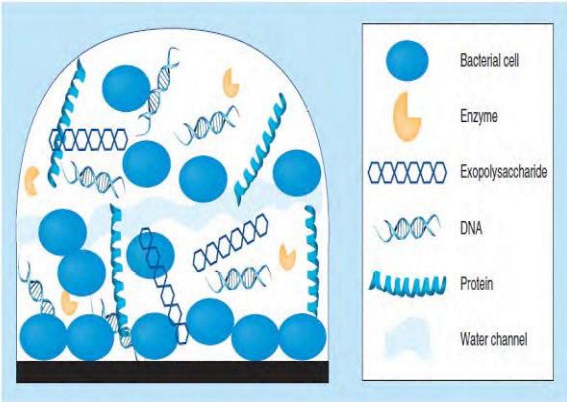
Characteristics of Biofilm

1. Biofilms are complex, dynamic and remarkably heterogeneous structures. Different biofilms exhibit different chemical and electrical properties. Moreover, the genetic expression is also different in biofilm bacteria as compared to the planktonic bacteria.

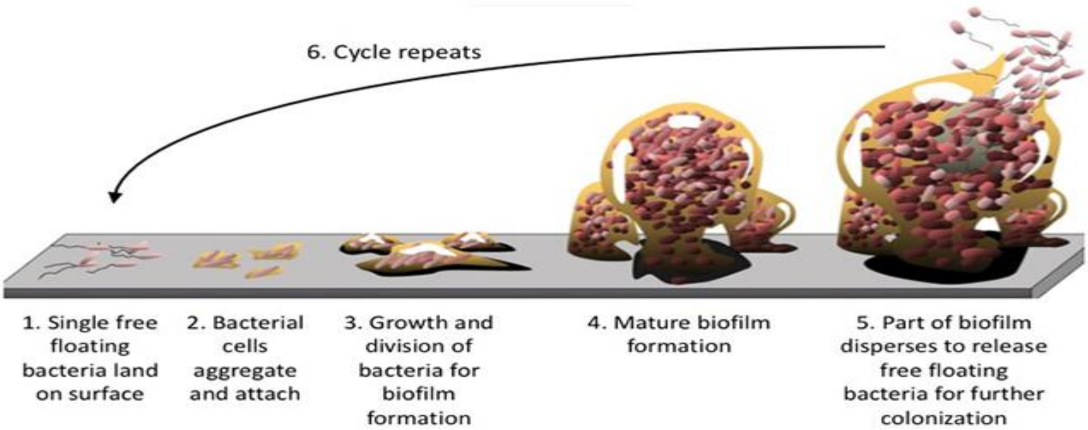
2. The cells are able to coordinate among each other via intercellular communication using biochemical signaling molecules (Quorum sensing).

3. The biofilm associated microbes are also much less susceptible to antimicrobial agents than those present in planktonic state. As a result, it becomes difficult to get rid of biofilms from the contact surfaces of food.

4. Stainless steel, polyvinyl chloride, polyurethane are the prolific surfaces for biofilm attachment when they come in contact with food materials.



Biofilm Formation Process



1. Initial reversible attachment: Biofilm formation -Starts attachment of plank tonic bacteria to solid surfaces. The reversible attachment is attained- between bacteria and surface through van der Waals and electrostatic forces. The direct contact with the surface material occurs via the surface appendages of bacteria such as flagella, fimbriae and extracellular polymers. During this stage cell exhibit logarithmic growth rate.

2. Irreversible attachment: The biofilm grows through a process of cell division and reversible attachment. This attachment, then, differentiates to irreversible attachment with the production of extracellular polymers (EPS) by the bacteria. Motility is decreased and cell aggregates are formed then it becomes layered.

3. Early development of biofilm structure: The EPS layer strengthens the structure between bacterial cells and the substratum. Over a period of time, the interactions and bonds are strengthened, making the attachment irreversible.

4. Maturation: During the maturation, the biofilm develops into an organized resistant structure to toxic chemicals and disinfectants. The irreversibly attached cells grow more by using available nutrients from the surrounding fluid environment and form microcolonies. Biofilm reach their ultimate thickness >100mm.

5. Dispersion: Bacterial cells are released from biofilm into the surrounding environment. The detached bacteria find new locations and restart the new biofilm formation. Detachment of biofilm aggregates by physical forces.

Conclusion

1. Biofilm formation possesses profound implications and throws a major challenge to the dairy sector where they act as the principal reservoir of microbial contamination.
2. Biofilms formed on milk-processing equipment and other food contact surfaces act as a persistent source of contamination threatening the microbiological quality and safety of milk products, and may result in food-borne disease and economic losses.
3. Therefore, good manufacturing practices (GMPs), good hygienic practice (GHPs) should be implemented.

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Nano-Catalysts

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Monika Moond[1], Sushila Singh[1], Seema Sangwan[2], Pooja[1], Jyoti Rani[1], Anuradha Beniwal[1], Pinki Matoria[1]

[1]Department of Chemistry, CCS Haryana Agricultural University, Hisar 125004, Haryana, India.
[2]Department of Microbiology, CCS Haryana Agricultural University, Hisar 125004, Haryana, India.

Introduction

Catalysis is a key component of chemical transformations and is at the core of innumerable chemical protocols. By employing catalytic reagents, one might potentially minimize unintended side reactions, lower the temperature of a transformation, reduce reagent-based waste, and increase the selectivity of a reaction, all of which could contribute to a green technology. In order to decrease or remove chemicals and chemical processes that have detrimental effects on the environment, Anastas and Warner proposed a set of twelve principles in 1998. One of the key ideas in green chemistry is the design and development of suitable catalysts (Anastas & Warner, 1998). Particles with a size of 1–100 nanometers are known as nanoparticles. The main objective of nanochemistry is the synthesis of stable nanoparticles with a size range of 1-100 nm. One of the most important applications of nanoparticles is in catalysis (Babu & Karvembu, 2013).

Properties of Nano-Catalyst

Nanocatalysts have properties of both the homogeneous and heterogeneous catalytic systems. Large nanoparticle surface areas have an obvious favourable impact on reaction rates and may also be a plausible explanation for their catalytic activity. Every material's catalytic activity can be influenced by its structure and shape-based characteristics at the nanoscale scale. More selectivity has been achieved through the careful adjustment of nanocatalysts in terms of composition (bimetallic, core-shell type, or usage of supports). Rapid, selective chemical transformations with great product yield are made possible by nano catalytic systems, which also make it simple to separate and recover the catalyst. The ability of any catalyst to be recovered from the system is one of the requirements for acceptance in industrial processes for the production of green chemicals (Tondon & Singh, 2014).

Factors Affecting Properties of Nano-Catalyst

1. Size
2. Shape
3. Spatial Distribution
4. Surface Composition
5. Thermal and Chemical Stability.

Efficiency of Nano-Catalysis

1. High activity
2. High Selectivity
3. Excellent Stability
4. Easily Separable
5. Energy Efficient
6. Atom Economy

Benefits of Using Nano-Catalysis

1. Energy efficient
2. Minimum Chemical waste
3. Super catalysts and reagents
4. Improved economy
5. Reduce global warming.

Conclusion

Development of nanotechnology opens new opportunities in the area of catalysis. In both academic and industrial research and development, nanocatalysis is a key component. The growing number of nanocatalysis-related patents, technology, and products on the market demonstrates the industrial importance of nanocatalysis. Metal nanoparticles created under size and shape control have great promise for more environment friendly heterogeneous catalytic processes. Nowadays, it looks highly optimistic that scientists will be able to resolve current environmental, social and industrial issues based on a better knowledge of the effects of nanoparticle size and shape and their interactions with support materials or stabilising agent.

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Hydoponics Rice Nursery

Article ID: 40626

V. Shiva Shridharan[1], E. Siva Sundar[1], Sreyaskumar J S[1], N. Srisaran[1]
[1]S. Thangapazham Agricultural College, Vasudevallur-627758, Tenkasi District.

Abstract
Hydroponics is science of growing Plants without the use of soil. The word Hydroponics has been derived from the Greek Word where 'Hydro' means water and 'Ponic' Means working, i.e., working with water. The Hydroponics technology can be applied in Several agriculture especially on raising paddy nursery. Currently a popular approach to grow rice in India. Because of the continual decrease in clean water supplies as a result of global warming and contamination of previously existing water sources. Need for hydroponically grown rice is to reduce water user efficiency for grow of paddy than normal plantation. And water consumption less than other type of growing paddy. And there are many advantages in using hydroponics in economical as well as essential commodities. Growing hydroponics having different steps such as outline of the nursery device, soaking of seeds, seeding method, germination of seeds, supply of fertilizer and air temperature, rolling up of seedling. Grow rice in aquaponics. Protocol for hydroponics in paddy nursery.

Introduction
Soil-based agriculture is now facing major challenges due to urbanization, industrialization and Environmental degradation etc. Hydroponic rice nurseries are currently a popular approach to grow rice in India. Rice is considered as one of the most water-intensive crops. Because of the continual decrease in clean water supplies as a result of global warming and contamination of previously existing water sources, this high use will become a major concern. As a result, rice's economic viability will be determined by the advancement of hydroponic technology. In traditional rice production, the necessity of constructing a proper paddy nursery cannot be overstated. The performance and yield of a rice crop are strongly affected by its early stages.

Transplanting seedlings at the right time is also critical for achieving the best yield. Indian farmers face a number of challenges, including constructing a healthy paddy nursery, transplanting survivability, disease, and so on. Additionally, the traditional mat-type nursery requires cumbersome, labour-heavy land preparation.

Need for Hydroponically Grown Rice

The conventional method of Rice cultivation necessitates a hot, wet, and humid climate. Farmers must water the plants and attend weddings on a regular basis. This results in a significant amount of freshwater waste. On the other hand, hydroponics uses 85% less water for growing. With respect to conventional system one kilogram of paddy seed require 3000-5000 litres of water. On top of that, farmers must spend hours knee deep in stagnant water to tend to their crops. As a result, farmers are at risk of contracting water-borne diseases.

Advantages

1. Reduce the nursery making area required for conventional farming (It uses 20% less space for growing with respect to conventional system)
2. The crops are grown under a controlled environment
3. Compared to traditional farming methods, this farming model can produce 7 to 14 times more growth cycles
4. The temperature, light, water, and nutrition can be fully adjusted to optimum conditions
5. Farmers do not have to battle vicious weeds and pests, and the crops are grown in a controlled environment protected from the harsh environment. This means that yields will be not only larger, but also much healthier and of higher quality.
6. Apart from the reduced water usage, farmers do not have to battle vicious weeds and pests.

Steps of Nursery Growing

Step 1: Outline of nursery device: The nursery bed fixed horizontally on the ground comprised 4-6 nursery trays. A nursertray (6.5 m long, 28 cm wide and 6 cm deep) made of stainless steel was developed. The height of the nursery tray from the ground surface was set at 60cm to work without bending the waist. Liquid fertilizer circulates in the tank and on the tray of the nursery device through a pump (Tasaka, 1999).

Step 2: Soaking of seeds: After the soaked rice seeds have dried for 24 hours, they can be germinated in a bucket. A mix of soil and compost, then filled with water, would be an accessible medium. Plant the seeds in the bucket and they should sprout in two weeks. The seeds ranged in mass from 100 to 250 g per unit.

Step 3: Seeding method: Eradicate the soil from the roots to avoid problems and for easier nutrient uptake. The roots should be in contact with the system's nutrient solution to guarantee growth. Adjust the temperature to around 77°F to encourage the rice's quick development (Sambo et al.,2019)

Step 4: Germination of seeds: Allow the seeds to germinate for up to two weeks. Keep in mind that the higher the temperature, the quicker they will germinate. After removing any remaining soil from the roots, place them in the hydroponic pot. Check that the roots are in contact with the nutrient solution.

Step 5: Supply of fertilizer and air temperature in the vinyl house: After sowing, water without fertilizer was cycled in the nursery device for several days. In the composition of the nutrient solution, appropriate concentrations of nitrogen, potassium, phosphorus, Calcium, magnesium, and Sulphur, as well as lower amounts of other elements, are necessary. On the fifth day after seeding, commercially available fertilizer is dissolved in water in the liquid fertilizer tank.

Step 6: Rolling up of seedlings: Rolling up of 6 m long mat were conducted for transfer to the paddy fields and loading on a rice transplanter. It takes about 20-30 days to mature.

Grow Rice in Aquaponics

Rice can be grown using aquaponics. In fact, the only difference between aquaponics and hydroponics is that aquaponics uses nutrients from fish waste to supply the plant instead of the traditional human-made nutrient solution used in hydroponics. However, using aquaponics instead of hydroponics is more complicated. (Horkey et al, 2021). But aquaponics somehow solved the reduced economic viability of hydroponic rice. By growing fish with rice, the final output will be nearly doubled as a result of the relatively high price of fish.

Protocol for Hydroponics Paddy Nursery

The Ayurvet Research Foundation was one of the first in the country to develop rice hydroponics technology. The commercial test report for the Ayurvet Pro Green hydroponics machine was issued by the Indian Ministry of Agriculture. The company has been working on the technology for the past ten years, and the machine structure and procedure have been granted a patent. Since 2009, the Ayurveda Research Foundation has performed studies and field trials with 2,500 paddy farmers in 50 villages, including Orissa in Western Uttar Pradesh and Sonipat and Panipat in Haryana (Saxena and Upadhyay, 2019). Regular training and demonstration sessions were organized for the farmers for making them aware of the technology. To date, a total of 81 hectares have been transplanted with rice seedlings grown using the hydroponics paddy nursery.

Conclusion

The government can assist Indian rice producers in saving considerable amounts of water, land, labour, time, and other resources by supporting the use of hydroponics paddy nursery. Free training for farmers in various sections of the country would raise their awareness of the technology and its benefits, empowering them. It will also provide them with information on how to create new sources of income.

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Gardens for Special Purposes

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Roshni Agnihotri[1]

[1]Assistant Professor (Floriculture), Tirhut College of Agriculture, Dholi, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar.

Special purpose gardens are created by communities to provide an outdoor environment that can be used for spiritual, cultural or other specific purposes. Green spaces and gardens are well known for their healing and therapeutic values and can also provide spiritual comfort and connection by using outdoor spaces for faith practices such as prayer and meditation. Gardens are perfect for these types of practices as they offer a quiet, serene space that can be used in three (or even four) seasons. Outdoor spaces can be created intentionally for this type of purpose or a current garden can be retrofit and revitalized.

Smaller special purpose gardens can offer a welcoming and colourful environment at a main entrance, a place to locate welcoming "open door" signage or symbolic art pieces, a place for familiar and symbolic plants (such as Bleeding Heart).

Larger special purpose gardens can offer the experience of physically entering into a sacred space, signified with stepping stones and/or path, the opportunity to retreat into a green space and peaceful scenery away from busy city distractions, an occasion to benefit from the softer colourful landscaping with seating areas and green vistas.

Healing/ Therapeutic Gardens

Healing gardens offer visitors a place to reconnect and heal whether emotionally or spiritually. These gardens have been installed in health care facilities to help patients heal faster through both being able to see green spaces and from visiting the gardens. Both a view of green landscapes and also immersion in a garden have positive effects for both mental and physical healing. Scientific studies have shown that immersion in green spaces can have many positive effects including: decreasing stress-levels, boost of positive outlook, lessening of depression and anxiety and increasing generosity. Due to these benefits, healing gardens have much to offer to all communities including faith and spiritual ones. Therapeutic gardens on the other hand involve the garden visitor in a more active deliberate way, whether it is by engaging the visitor with different senses (sight (colour/texture), smell, touch, etc) or by offering an opportunity to regular visitors to actually participate in the care of the garden.

Gardening activities offer even more opportunities to engage the senses, such as the physical touch and scents of the soil, the handling of colourful plants and the watering and nourishment of the garden.

Meditation/ Prayer/ Quiet Gardens

Meditation, prayer and quiet gardens offer a peaceful space for solitude and reflection. This type of contemplative activity can be heightened by being outside in a garden setting. Being surrounded by the flourishing plants and active wildlife can provide a direct sense of the miracles of creation.

For those faith communities that want to offer a prayer/meditation garden, visitors will require a comfortable and sheltered place to sit – such as a bench or a grassy hill overlooking an uplifting vista. These types of gardens need to be buffered from busier areas such as building paths and parking lots or streets. Having a transitional space as visitors move from busier spaces to the solitude of the garden can help visitors mentally unplug.

If the garden is for a specific faith community, religious and spiritual symbols and visual reminders provides visitors with familiar clues and a more direct way to connect with their faith. These gardens should provide a place of solace and peace and help uplift and provide a sense of renewal.

Labyrinth Maze and Garden

A labyrinth maze is a special type of prayer/meditation space. It can be very simple and designed either into a grass path or laid out with paver stones. The labyrinth walk mimics a religious pilgrimage, where one can embarks on a journey into the centre of the labyrinth, (which symbolizes the Universe or Creator), rest once they are in the centre and then journey back outwards (back "home") while reflecting on any inspiration or messages received during the walk.

It is suggested that the labyrinth walk starts with a question or prayer before one starts the walk and then the path of the labyrinth twists and turns towards the middle, such as many journeys do. The centre of the labyrinth offers mediators a time for reflection and opening to receive any messages or wisdom about the question, prayer or journey.

Pollinator Garden

Pollinators thrive on flower nectar and pollen. A section of the landscape must be designated strictly for a pollinator garden filled with a multitude of grasses, trees, shrubs and wildflowers. A site is selected that receives at least six hours of sun each day. If space is limited, pollinator garden plants are grown in containers filled with rich, well-drained soil. Water sources are provided for the pollinators. For instance, many pollinators, such as butterflies, like to gather at and sip water from shallow pools, mud puddles or birdbaths. Native plants are well suited to meet the needs of native pollinator species. In fact, many of these creatures are actually dependent on them. Since pollinators have different needs during different life cycle stages, maintaining diversity will make the pollinator garden more appealing. For example, the greater variety of plants present the more pollinators the garden will attract. Diverse plantings are also more likely to attract beneficial insects and birds, as opposed to harmful pests.

Butterflies are attracted to red, orange and yellow while Hummingbirds prefer red, fuchsia and purple. Fragrant flowers signal many pollinators, including those that only come out at night, such as moths and bats. The shape of a flower is also important for pollination. Plants and wildlife go hand in hand. Plants benefit from attracting pollinators to their flowers. Pollinators benefit from the food resources of plants, and pollination is an essential part of a healthy ecosystem. Without it, most plants could not produce fruit or set seed. If it were not for the flowers and pollinators, we would not be able to enjoy the fruits of their labor.

Cutting Gardens

Growing cutting gardens is a worthwhile experience for anyone who wants a vast array of beautiful flowers to adorn their garden and home. One need not to be an expert gardener in order to create an attractive, thriving cutting garden. There is no one-size fit all plan to growing a cutting garden either. Some gardeners prefer to grow their flower cutting garden in rows and in a very organized fashion, while others simply scatter them throughout their landscape.

Choosing Cutting Garden Plants: Choosing flowers for a cutting garden can be a bit overwhelming as there are so many to choose from. The best thing to do when planning flower-cutting garden is to collect a few seed catalogues and find the flowers that best suit one's taste and growing conditions. It is suggested to pick flowers that bloom at different times so that there's always have some color in garden.

Perennials will bloom year after year and provide a strong foundation in a cutting garden. Some perennials for a flower cutting garden include: Black-eyed Susan's Yarrow Peonies Purple coneflowers. Woody plants are also beautiful in vases and include fragrant lilacs and roses.

Annuals will bloom for one season; however, many annuals will self-seed and pop up again the next year. Some annual cutting garden flowers include: Zinnias, Sweet peas, Globe amaranth and poppy.

Bulbs can also make a pleasant addition to any formal or informal cutting garden. Common bulbs to use when growing cutting gardens include: Calla, lilies, Gladiolus, Dahlias.

Hummingbird Garden

Hummingbirds are a delight to watch as they dart and dash around the garden. To attract hummingbirds to the garden, planting a perennial garden for hummingbirds is considered.

How Can One Attract a Hummingbird to Garden?

When attracting hummers to your garden, you should keep in mind that hummingbirds prefer to feed in shady areas and they need plenty of open space for flying. Adding appropriate feeders and flowers will also help to welcome these creatures to the area. Feeders An easy method of attracting hummingbirds to the garden is to hang hummingbird feeders. Hummingbird feeders can provide the amount of nectar found in 2,000 to 5,000 flowers.

Some of the best flowers for attracting hummingbirds to the garden include those that are orange or red in color and tube shaped. Some native American wildflowers that naturally attract hummingbirds include: Bee-balm, Columbine, Cardinal flower, Jewelweed. Hummingbirds also visit many other flowers in the garden, such as various types of lilies. Many perennial plants and trees make the best flowers for attracting hummingbirds and include: Scarlet sage, Daylilies, Honeysuckle, Cannas, Spider flower, Morning glories, Petunias, Fuchsias.

Sensory Gardens

Sensory gardens strive to maximize the sensory impact that the garden has on its visitors. Sensory gardens can be themed, divided into sections or presented as a whole. Sensory gardens are user friendly and encourage garden guests to touch, taste, admire and listen. Creating a sensory garden is an exciting and worthwhile project that provides limitless opportunities to teach and exercise horticultural healing therapy techniques.

The beauty of sensory gardens is that they can be adapted to a wide variety of users. Start with a well thought out plan and be sure to accommodate space for the mature size of plants chosen. Hardscape elements such as benches, paths, water fountains, bird feeders and garden art are also incorporated into the sensory space for an added effect. Include plants and other things that entice the senses.

Sound – To stimulate hearing, choose plant flora that makes noise when the wind passes through them, such as bamboo stems. Many seedpods make interesting sounds as well, and the end of season leaves provide a fun crunching sound under feet. Plants that encourage wildlife in the garden can also be selected. The buzzing of a bee, the chirping of a cricket or the whizzing of a hummingbird all stimulates the sense of hearing.

Touch – There is no shortage of plants that offer interesting textures, perfect for encouraging the sense of touch. From the baby soft feel of a lamb's ear to the irresistible sensation of cool moss through the fingers or rough seedpods, it is possible to incorporate many different textures into the garden. Dangerous plants should not be planted, however, such as prickly roses or spiny agaves.

Smell – The sense of smell is extremely memorable, and aromas easily find their place in our memory banks. Most sensory gardens are full of mingling aromas that entice a wide range of emotions. Highly aromatic plants such as the sweet-smelling gardenia, honeysuckle, herbs and spices, provide ample opportunity for stimulation.

Sight – Adding visual interest to a sensory garden can be achieved by using plants with varying habits such as those that creep, climb, trail, bush or stand upright. Plants with different bloom, leaf, bark and stem colours are incorporated to provide visual appeal as well.

Taste – Edible fruits, herbs and spices planted in a sensory garden allow visitors an opportunity to experience nature's bounty while enticing their taste buds. Vegetables can also arouse the taste buds.

Moonlight Garden

A moon garden is simply a garden that is meant to be enjoyed by the light of the moon, or at night time. Moon garden designs include white or lightly coloured blooms that open at night, plants that release sweet fragrances at night, and/or plant foliage that adds a unique texture, colour or shape at night. Plants with light blooms that open at night will reflect the moonlight, making them pop out against the darkness. Some examples of excellent white blooms for moon gardens are: Moonflower, Nicotiana Brugmansia, Mock orange, Petunia, Night blooming jasmine Cleome Sweet Autumn clematis Some of the above-mentioned plants, such as night blooming jasmine, petunia and Sweet Autumn clematis pull double duty in moon garden designs by reflecting moonlight and releasing a sweet fragrance.

This fragrance is actually intended to attract night time pollinators like moths or bats but their scent adds a relaxing ambiance to moon gardens. Plants with blue, silver or variegated foliage, such as Artemisia, blue fescue, juniper and variegated hosta also reflect the moonlight and add interesting shape and texture to moon garden designs.

Legacy Garden

A legacy, according to Merriam-Webster, is something transmitted or received by an ancestor or predecessor, or from the past.

What is a Legacy Garden? Here's one useful way to look at creating legacy gardens: A legacy garden involves learning about the past, growing for the future, and living in the present time. When it comes e5to legacy garden ideas, the possibilities are nearly endless, and nearly any type of plant can become a legacy garden plant.

For example: **Legacy Garden ideas for schools** – Most schools aren't in session during the summer months, which makes gardening projects very challenging. Some schools have found a workaround by creating a legacy garden, in which schoolchildren plant crops in spring. The legacy garden is harvested by incoming classes in autumn, with families and volunteers tending the plants during the summer; **College legacy garden** – A college legacy garden is similar to a garden for younger children, but is considerably more involved. Most legacy gardens created at colleges allow students to become directly involved with land use, soil and water conservation, crop rotation, integrated pest management, use of flowers for pollinators, fencing, irrigation, and sustainability; **Community legacy gardens** – Many corporations with an extra patch of land are putting that land to good use with a legacy garden that involves a partnership with employees and community members. Vegetables are shared among participating gardeners with excess donated to food banks and the homeless. Most corporate legacy gardens include an educational aspect with training sessions, workshops, seminars and cooking classes; **Legacy trees** – A legacy tree in honor of a special person is one of the easiest ways of planting a legacy garden – and one of the most long-lasting. Legacy trees are often planted at schools, libraries, cemeteries, parks or churches. Legacy trees are typically selected for their beauty, such as hackberry, European beech, silver maple, flowering dogwood, birch or flowering crabapple; **Memorial legacy gardens** – Memorial gardens are created to honor a person who has died. A memorial garden may involve tree, flowers, or other legacy garden plants, such as roses. If space allows, it may include walking paths, tables and benches for quiet contemplation or study. Some legacy gardens feature children's gardens.

Rain Garden

Rain gardens are quickly becoming popular in the home garden. A pretty alternative to more conventional methods of improving yard drainage, a rain garden in one's yard not only provides a unique and lovely feature, but can also help the environment. There are a few things to keep in mind when deciding where the rain garden will go : **Away from the house** – While rain gardens are lovely, the point of them is to help draw away water runoff. None want to draw water to the foundation. It is best to place rain gardens at least 15 feet away from home, **Away from septic system** – A rain garden can interfere with how septic system operates, so it is best to locate it at least 10 feet from a septic system, **In full or part sun** – Put rain garden in full or part sun. Many rain garden plants work best in these conditions, and full sun will also help water move on from the garden, **Access to a downspout** – While one should not place rain garden near the foundation, it is helpful for water collection if it is placed where one can extend a downspout out to it.

Rain Garden Plantings - There are many plants to use for rain garden plantings. The list below of rain garden plants is just a sample: Blue flag, Bushy aster, Cardinal flower, Cinnamon fern, Sedge Dwarf cornel, False aster, Fox sedge, Glade-fern, Grass-leaved goldenrod, Heath aster, Jack-in-the-pulpit, Lady fern, New England aster, New York fern, Nodding pink onion, Maidenhair Fern, Ohio goldenrod, Prairie blazingstar, Wintergreen Yellow coneflower.

Edible Garden

Edible landscaping is simply a way of using veggies, herbs and flowers in the garden that will perform multiple functions, such as for food, flavour and ornamental appearance. However, grouping veggies, herbs and flowers together is a great way to add interesting textures and colours to the garden. Mixing vegetables and herbs with flowers also creates year-round interest. Many gardeners also prefer to mix these plants to camouflage and repel pests.

For even more beauty and extended blooms, mix some edible flowers in with vegetables and herbs. It's not only a great way to extend the look of the garden, but it will also increase overall yields. Afterall, it's an edible garden. Why not have the best of both.

Butterfly Garden

If anyone like to see the butterflies gracefully dancing about smiling blooms of garden, planting some flowering plants that help attract them is a great thing to do. Also, one may create a bed with butterfly garden plants as it will not only attract the butterflies but other wonderful garden visitors such as the delightful hummingbirds.

List of Butterfly Garden Plants: The beauty and grace that butterflies bring to the garden are far greater than any other garden ornament. Here is a listing of some plants that attract butterflies: Achillea, Yarrow Asclepias tuberosa, Butterfly Milkweed, *Gaillardia grandiflora,* Blanket Flower, Alcea rosea, Hollyhock, Helianthus, Sunflower Chrysanthemum maximum, Shasta Daisy Lobularia maritima, Sweet Alyssum, Aster, Rudbeckia hirta, Black-eyed Susan or Gloriosa, Daisy, Coreopsis, Coreopsis Cosmos, Cosmos Dianthus, Dianthus Echinacea purpurea, Purple Coneflower, Roses, Verbena bonariensis, Verbena, Tagetes, Marigold Zinnis elegans, Phlox.

This is just a partial listing of some of the flowering plants that attract butterflies to gardens, and they not only attract these beautiful, graceful visitors but add colourful beauty to gardens as well.

Role of Allelochemicals in Development of Insect Resistance Varieties

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Moirangthem Monalisa Devi[1]
[1]Ph.D Scholar, Department of Entomology, College of Agriculture, Central Agricultural University, Imphal, Manipur.

The development of crop plant varieties with resistance to insects and diseases has several advantages compared with other approaches to pest control because of economics, environmental considerations, and relative efficiency. In this context, allelochemicals are taken into account. Allelochemicals are non-nutritional secondary metabolites produced by living organisms (i.e., plants) that have stimulatory or inhibitory effects upon the growth, health, behavior, or population biology of neighboring organisms (plants, insects, microbes, etc.). It has the capability of acting as natural pesticides on plant body and might resolve issues like resistance development in pest biotypes, health defects, soil and environmental pollution caused by the indiscriminate use of artificial agrochemicals Allelochemicals are broadly classified into Synomones, Kairomones, Allomomes.

Plant Produced Synomones

	
Anatis ocelleta	***Podisus maculiventris***

Substance produced by an individual of one plant species that benefits both the producer and the recipient is called as synomones. The best known and most prevalent plant- hervibore synomonal interaction link is between the flowering plants and their pollinators. Floral volatiles benefit plants by attracting pollinators and benefit insects by serving as nutrition and mate location sign posts.Plant odour act as synomones in tritrophic level of interaction. *Anatis ocelleta*, the coccinelid predator of the pine aphid, orients to pine needle odors, shown in the picture. (Kresten, 1969). Some exciting examples is that some plants respond to feeding of tissue damage by emitting synonymes attractive to herbivores natural enemies i.e plant sending the SOS chemical when attack. Eg. *Podisus maculiventris*, the spined soldier bub orients to soybean plants damge by *Trichoplusia ni*,(Greany and Hagen 1981).

Herbivore Released Synomones

Synomone mediation of herbivore-predator interactions is illustrated by the nonnutritive ant attractants, arrestants and feeding stimulants produced by aphids, treehoppers and lycaenid butterfly larvae. Strong mutualistic associations evolved between certain ant and aphid species whereby the ants protect the aphids from predators and parasitoids and even move them senescent to fresh plant. In return aphids provide ants with carbohydrate and amino acids containing honey dew.

	
Ants and Aphids association	**Ants and lycaenid butterfly**

Plant Produced Kairomones

Kairomones are the substances that gives adaptive advantage to the receiving organisms i.e the phytophagous insects. The plant produced substances that serve as attractants and oviposition and feeding stimulants for herbivores are the best known kairomones. Kairomones A **kairomone** paralleling is a chemical emitted by an organism, which mediates interspecific interactions in a way that benefits an individual of another species which receives it and harms the emitter.

Herbivore Released Kairomones

Carnivores utilize a variety of stimuli to locate and identify their prey, including chemical cues emanating from their prey. Numerous kairomones have been documented for vertebrate predators and insect parasitoids. Kairomone use by insect predators is less well known, but some examples exist. Larvae of *Chrysoperla carnea* respond to kairomones emanating from *Heliothis zea* eggs as well as scales left behind by the ovipositing moth adults (Lewis et.al,1977).

Allomones

The primary plant defense against herbivory is the possession of toxic or repugnant allomones. These substances repel, deter or harm many potential or actual phytophages (Rosenthal and Janzen 1979). The direct effects of plant allomones on herbivores are well established but a growing searching suggests that plant allomones can indirectly yet substantially affect the herbivore-carnivore trophic level as well. Moreover, herbivores obtain or synthesize a variety of substances which when released into the environment prove advantageous for the herbivore but detrimental of other organisms.

Resistance in Plants Due to the Presence of Allelochemicals

Ostrinia nubilalis

1. Resistance in maize to the European corn borer, *Ostrinia nubilalis* is the most classical examples of exploitation of allelochemicals.
2. The chemical compound resistance factor MBOA, appears to function as a repellent and feeding deterrant.
3. MBOA doesnot exist in uninjured corn instead DIMBOA in its glucoside form is present in uninjured corn leaves.

4. Injury to the plant tissue due to larval feeding results in the enzymatic conversion of glucoside to the aglycone DIMBOA. DIMBOA decomposes in a reaction to yield MBOA and formic acid.
5. A correlation between the DIMBOA content of maize varieties and resistance to Ostrinia nubilalis larvae has been established and it has been suggested that it could form the basis of a rapid method for assessing resistance.
6. Resistance in maize to the south western corn borer, Diatrea grandiosella has been identified because of the presence of N-O-ME-DIMBOA.
7. It is present in the corn whorl surface waxes at a higher concentration than DIMBOA or MBOA.
8. In cotton the major allelochemicals imparting resistance has been found to be Gossypol which is found in higher quantities in glanded varieties than in glandless varieties. Moreover, heliocide 1, heliocide 2, gossypolone, hemigossypolone, lactone, condensed tannins and volatile terpenes in cotton confer resistance to bollworms.
9. Substances like gallic, vanillic and salicylic acid have been known to impart resistance against *Helicoverpa armigera* and *Spodoptera litura.*
10. Components including volatiles, amino acids and trans acotinic acid are involved in host plant resistance in rice to several insect pests.
11. A chemical "pentadecanal has been isolated from TKM 6, a *Chilo suppressalis* resistant rice variety.
12. The methyl ketones, 2- tridecanone, 2- undecanone present at the tip of the wild tomato, *Lycopersicon hirsutum* is resistant to the tomato pests, *Manduca sexta* and *Helicoverpa zea.*
13. In cucurbitaceae family, a chemical compound cucurbitacins, a group of 20 tetracyclic triterpenoids act as a feeding deterrent for a number of insect pests including cucumber leaf beetles*, Phyllotetra* spp., *Phaedon* spp. and *Cerotoma trifurcate*, Stem borer, *Margonia hyalinata*
14. In potato, concentrations of glycoalkaloids, solanine and chaconine are associated with resistance to *Empoasca fabae.*
15. These compound act as a stimulant for spotted cucumber beetle, *Diabrotica undecimpunctata.*

	
***Phyllotetra* spp.**	***Ceratoma trifurcate***

16. Gramine has been found out to be one of the factors responsible for resistance of barley seedlings to *Rhopalosiphum padi.*
17. 3-nitropropionic acid from crown vetch was a feeding deterrent, and also toxic to some insects and non-ruminant animals.
18. The resistance of an isogenic strain of barley to greenbug, *Schizaphis graminum* was reported to be governed by benzyl alcohol.

	
Rhopalosiphum padi	***Schizaphis graminum***

19. Higher amount of malic acid in chickpea and stilbene in pigeonpea are associated with resistance to *Helicoverpa armigera*.
20. Pinitol confers resistance to *Helicoverpa zea* in soybean.
21. The development of tomato plant lines rich in acyl sugars (AS), zingiberene (ZGB), and 2-tridecanone (2-TD) is an effective option for indirect selection for resistance to B. tabaci biotype B.

Dual Role of Allelochemicals in Insect Plant Interactions

Plant allelochemical may play the dual role of repellent as well as attractant to different insects. The classical example is that the glucosinolates and their hydrolysis products are highly toxic to swallowtail butterfly, *Papillio polyxenes* but a feeding stimulant and provide host plant recognition clues for *Pieris brassicae*. This classic example suggests that a chemical messenger can act as double agent. Here are some of the examples of dual action of chemicals.
1. The allelochemical produces by cotton plant “Gossypol” has a stimulant action to *Anthonomus grandis* but they act as deterrant to *Helicoverpa zea*
2. The allelochemical “Tomatine” has a stimulant action to *Pieris brassicae* but they act as deterrant to *Leptinotarsa decemlineata.* and *Emproasca fabae.*
3. The allelochemical “Lupanine” has a stimulant action to *Macrosiphon albifons* but they act as deterrant to *Acyrthosiphon pisum.*
4. The allelochemical “cucurbitacin” has a stimulant action to *Diabrotica undecimpunctata* but they act as deterrant to *Epilachna tredcimnotata.*
5. The allelochemical “furanocoumarins” has a stimulant action to *Papilio polyxenes* but they act as deterrant to *Spodoptera exempta*
6. Several diterpenes and sucrose esters were inhibitory to etiolated wheat coleoptiles and microbes, but oviposition stimulants for the tobacco budworm, *Hellothis virescens.*

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Autonomous Vehicles for Precision Agriculture

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A Ajay[1]
[1]Department of Farm Machinery and Power Engineering, Kelappaji College of Agricultural Engineering and Technology, KAU, Thrisur, Kerala, India.

Summery
The ability of farmers and other agricultural stakeholders to utilize the benefits of technology and adopt it for agriculture sector is the very important factor for the success of agriculture in the future. So, there is a need to improve the technologies, so that we can feed more people as efficiently as possible. Recently, the advent of different autonomous vehicles ranging from different fields of operations was developed in the industry. Autonomous vehicles can play an essential role to reach the needs of the future agriculture production.

Introduction
Agriculture is the most important sector on earth. With the increasing population, the demand for crops and livestock will soon be higher than ever. So, there is a need to improve the technologies, so that we can feed more people as efficiently as possible. Modernization of agriculture is to enhance the efficiency and productivity of farming without causing any damage to the resources. Precision agriculture is a new technology adopted all over the world to enhance production, reduce labour time, and ensure the effective crop management. From the past few years these technologies playing an important role in agriculture. The future concept of agriculture contemplates more intelligent farm that are more efficient and environmentally more suitable, with sensors, machines, robots, and information technology. Recently, the advent of different autonomous vehicles ranging from different fields of operations was developed in the industry, but all these products are available in commercial and expensive. Autonomous vehicles can play an essential role to reach the needs of the future agriculture production. These can improve the operational safety, soil health, and increase yields. Autonomous vehicles are light in weight, it will help to reduce the problems associated with topsoil compression in agriculture.

Autonomous Farm Tractor
A self-driving tractor is an autonomous farm vehicle it consists of various components such as cameras, sensors, radar, and artificial intelligence (AI) to do the different operations in the field without operator. It is also called as autonomous or driverless tractor. These vehicles identify their location, calculates their speed, and avoid obstacles such as people and animals while operating in the filed with the help of programmed software. Autonomous vehicles are classified in to two types based on the operating system, one is fully autonomy and another one is supervised autonomy. Global Positioning System (GPS) and other technologies were used in the tractor to do operations in the field without a driver.

The tractor will be directed remotely by directing into areas of the farm that have already been mapped. Obstacle detection sensors are fitted to the vehicle these sensors detect the obstacles in the farm and it will stop the vehicle if any obstacle in the field. Hence, the field should be cleared of all hurdles before starting the operation. In some cases, the obstructions are permeant, the vehicle stops and send signals to the operator, then operator directs the vehicles with the help of controls fitted in the tractor.

Two different methods to building and programming the tractors are:

1. Full autonomy: The navigation system in fully autonomous tractors works using lasers that will produce signals from different mobile transponders around the field. Instead of drivers, the tractors have controllers. With the aid of controllers, an operator at one location can supervise multiple tractors on multiple locations.

2. Supervised autonomy: Tractors that function with supervised autonomy use vehicle to vehicle technology and communication. There is a wireless connection between the two tractors to exchange and share data. The leading tractor determines speed and direction which is then transmitted to the driverless tractor to imitate.

Fig. 1 Autonomous farm tractor
(Source: https://www.goodnet.org/articles/autonomous-tractors-are-transforming-agriculture)

Advantages of Autonomous Tractor

1. Accurate and efficient farming.
2. Avoiding human errors.
3. It saves time and money.

Conclusions

Autonomous farm tractors will enable farmers to fully automate their operations, it will reduce all the labour cost and time of operation. The application of new agricultural mechanization technology will increase the overall productivity and reduce the cost of cultivation in agriculture. Production and productivity cannot be enhanced with primitive and traditional seeding methods. Certain advanced technologies are adopted for the precision agriculture.

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Automated Rubber Tapering Machine

Article ID: 40630

A Ajay[1]

[1]Department of Farm Machinery and Power Engineering, Kelappaji College of Agricultural Engineering and Technology, KAU, Thrisur, Kerala, India.

Summery

Natural rubber is originally obtained from latex, it is a milky colloid which is produced from some plants. The rubber trees grow in tropical climates and is cultivated in many countries. The process of extracting latex from rubber trees is called as rubber tapping. Mostly the tapping operation is performed by manually and it requires skilled labour. The rubber planters are facing a serious shortage of tappers. Automated rubber tapping machine which can automate the process of rubber tapping reducing the labour requirement to a minimum.

Introduction

Rubber is a substance which have a special characteristic such as elasticity, friction, softness, durability, and very high electrical resistivity, hence rubber is an essential product in our daily life. Natural rubber is originally obtained from latex, it is a milky colloid which is produced from some plants. On the bark of the tree, an incision is made to collect the latex from the plants and it is refined into usable rubber. Natural rubber is a form of polyisoprene, which can also be made synthetically. Generally natural rubber is used more in many applications compared to the synthetic rubber. The rubber trees grow in tropical climates and is cultivated in many countries. About 90% of the total world production of rubber was produced from Asia.

The process of extracting latex from rubber trees is known as rubber tapping. Every night a thin layer of bark will be removed from tree in half spiral shape to one side. If done correctly the rubber tree will give the yield up to five years. Later the opposite side will be tapped, allowing this side to heal over. Latex from the spiral cut will be collected in a cup. Tapping of rubber was done at night or in the early morning before the day temperature raises, so the latex will drip longer before consolidation and sealing the cut. Depending on the product, additional chemicals can be mixed to the latex cup to store the latex for longer time. Mostly the tapping work is performed by manually and it needs skilled labour. In future, the world is going to face a shortage in availability of labours. Automated rubber tapping machine which can automate the process of rubber tapping reducing the labour requirement to a minimum.

Automatic Rubber Tapping System

A fully automated rubber tapping machine does not require manual carriage from tree to tree. It consists of several important components. Tapper head is the very important component in the system, it includes sensors and camera and can capture the images of the rubber tapping path and determine the trajectory of the cut. The main components are:

1. Tapper head
2. Rotary cutter and cutter head mechanism
3. Tapping head carriage
4. Main carriage.

Sensors will detect the distance between the trees and select the depth of the incision on the bark of the tree. Tapping head move along the tapping trajectory with the help of head carriage, which is mechatronics system. At the same time, the main carriage is an arrangement to carry the rubber tapping machine from tree to tree during the tapping process. All these units are controlled by a single controller unit (Yatawara *et al,* 2019). The controlling unit of the tapping machine is responsible for many functions including image processing for trajectory identification, controlling the horizontal, vertical and depth movements by driving the appropriate motors, and identification of the presence of a rubber tree with an infrared proximity detector.

Fig. 1. Fully automated rubber tapering machine (Yatawara *et al,* 2019)

Conclusions

Automated rubber tapping system is a new technology in the field of rubber tapping, where it needs skilled persons for rubber tapping. It makes simpler and automates the whole process. It is very economical to the farmers and reduces cost of operation. The quality and production of rubber will increase.

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Nutraceutical Properties of Fish Protein Hydrolysates

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M. Bhargavi Priyadarshini[1]
[1]Assistant Professor, Department of Fish Processing Technology and Engineering College of Fisheries, Central Agricultural University, Lembucherra, West Tripura-799 210.

Introduction

Protein hydrolysates consists of relatively small bioactive peptides (2–20 amino acids) can be obtained from fish waste (Sarmadi *and Ismail*, 2010) and fishes having low commercial value. The characteristics and quality of fish protein hydrolysates are highly influenced by several factors, including the type of proteases or chemicals used, temperature, pH, and duration of hydrolysis (Nazeer *and Kulandai*, 2012). Fish protein hydrolysates (FPH) are soluble proteins and peptides, as well as free amino acids that have demonstrated in many cases remarkable in vitro biological activities such as antioxidant, antiproliferative, antihypertensive, etc. (Vázquez *et. al.*, 2020). From fish different types of hydrolysates can be extractedbased on their origin they are known as fish skin protein hydrolysates, fish head protein hydrolysates, fish muscle protein hydrolysates, fish visceral protein hydrolysates, fish liver protein hydrolysates, fish bone protein hydrolysates and fish roe or egg protein hydrolysates. FPH is produced by chemical, enzymatical and microbial hydrolysis processing methods. The FPHs are amorphous and hygroscopic in nature. The proximate composition of FPHs contains 81–93% protein, less than 5 % fat and 3–8 % ash and 1–8 % moisture (Venugopal, 2016).

Nutraceutical Properties of Fish Protein Hydrolysates (FPH)

A nutraceutical product may be defined as a substance, which has a physiological benefit or provides protection against chronic disease. Nutraceutical does not require patent protection. Some of the properties of bioactivity are discussed below

1. Antioxidant activity of FPH's: Several factors including amino acid composition, side chain and chain length have been known to govern antioxidative activity (Intarasirisawat *et. al.*, 2012). FPH's prepared with different enzymes most possess peptides of differing lengths and amino acid sequences that may determine their antioxidant capacities (Godinho *et.al.*, 2016). The antioxidative protein hydrolysates or peptides can be produced from fish protein sources by using various processes such as *in vitro* enzymatic hydrolysis, autolytic process using endogenous enzymes, microbial fermentation, and simulated gastric digestion (Chalamaiah *et. al.*, 2012). Some of the research suggested that presence of peptides with amino composition tryptophan, tyrosine, methionine, histidine, proline, serine, tyrosine, valine and the presence of leucine and phenylalanine residues at the N or C peptide termini affected antioxidant activity of the fish protein hydrolysates.

2. Antimicrobial activity of FPH's: *Scorpaena notate* (small red scorpionfish) viscera protein hydrolysate prepared using the purified serine protease (Th-Protease) with a peptide sequence identified as FPIGMGHGSRPA exhibited remarkable in vitro antibacterial activities (Aissaoui *et. al.*, 2017). The antibacterial peptide Sm-A1 (GITDLRGML-KRLKKMK) from turbot (*Scophthalmus maximus*) that has excellent antibacterial activity against both gram-positive and gram-negative bacteria (Bi *et. al.*, 2020).

3. Immunomodulatory or anticancer protein hydrolysates of FPH's: Several immunomodulatory and anticancer peptides have been identified from fish and shellfish. In in-vivo animal studies protein hydrolysates prepared from Pacific whiting (Fermentation), *Oncorhynchus keta* (complex protease), Oyster (*Crassostrea gigas*) (protease from *Bacillus* sp. SM98011), Oyster (*Crassostrea hongkongensis*) (Bromelain, pepsin and trypsin), rohu (*Labeo rohita*) egg (roe) (Pepsin, trypsin and Alcalase), shark (Trypsin and chymotrypsin), common carp (*Cyprinus carpio*) egg (roe) (Pepsin, trypsin and Alcalase) and alaska pollock (Trypsin) have exhibited significant immunomodulatory activity (Chalamaiah *et. al.*, 2018).

Conclusions

Extraction of fish derived protein hydrolysates from low commercial value fishes and fish waste will not only reduce the post-harvest handling losses but yield the high valuable products containing the bioactive properties. Various protein hydrolysates can be generated using multiple methods, and they may be utilized to develop functional foods with diverse bioactivities that address the relevant issue.

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Food Nutrition

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P. S. Sapariya[1]

[1]Ph.D. Scholar, Department of Processing and Food Engineering, Junagadh Agricultural University, Junagadh, Gujarat-362001.

Introduction

Nutrition is the process by which body utilizes food for growth and maintenance and healthy living. It is the combination of processes by which the living organism receives and uses the food materials necessary for growth, maintenance of function and repair of component parts. Nutrition is the science of foods, nutrients and other substances, they are in action, interaction, and balance in relationship to health and disease; the process by which the organism ingests, digests, absorbs and utilizes nutrients and disposes of their end products (Robinson, 1965).

Nutrients are substances required by the body to perform its basic functions. Nutrients must be obtained from our diet, since the human body does not synthesize or produce them. Nutrients have one or more of three basic functions: they provide energy, contribute to body structure and regulate chemical processes in the body. These basic functions allow us to detect and respond to environmental surroundings, move, excrete wastes, respire (breathe), grow and reproduce.

Role of Nutrition

1. Nutrition promote the physical and mental growth and development of human beings.
2. Building and repairing of tissues and cell damaged by infection and injuries.
3. It provide energy for doing works.
4. It protect the human beings from infections and deficiency disorders.

Nutrients

Food contains several chemical constituents, which are known as nutrients. These include protein, carbohydrates, fats, minerals and vitamins (Swaminathan, 1995). Different nutrients supplied by foods to our body. Each nutrient has its own specific function. Most of the foods contain more than one nutrient. Nutrients are divided into two parts mainly as Macronutrients and Micronutrients.

1. Macronutrients: Macronutrients are essential for human survival and growth. These are carbohydrates, proteins and fats. For proper utilization of macronutrients needs micronutrients.

2. Micronutrients: Micronutrients requires in small quantity but necessary i.e. vitamins and minerals. The quantity of nutrients required depends upon age, gender, weight, physical activity and health status of the body.

Food: A Better Source of Nutrients

The term food embraces those substances, which are taken into the body to support growth, maintain body functions, repair or replace tissues and provide energy (Burton and Benjamin, 1959). It is better to get all your micronutrients from the foods you eat as opposed to from supplements. Supplements contain only what is listed on the label, but foods contain many more macronutrients, micronutrients, and other chemicals, like antioxidants, that benefit health.

Nutritional Classification of Foods

Since foods vary widely in their contents of various nutrients, they have been broadly grouped under three heads from the nutritional point of view:

1. Energy Yielding Foods: Foods rich in carbohydrates and fats are called energy yielding foods. Cereals, root & tubers, dried fruits, sugar and fats are included in this group. Cereals contain in addition, fair amount of proteins, minerals and certain vitamins.

2. Body Building Foods: Foods rich in protein are called body-building foods. Milk, meat, fish, eggs, pulses, oilseeds, and nuts and low-fat oilseed flours are included in the group of body building foods.

3. Protective Foods: Protective foods are broadly classified into two groups:

a. Foods rich in vitamins, minerals and proteins of high biological value e.g. milk, eggs and liver.
b. Foods rich in certain vitamins and minerals only e.g. green leafy vegetables and fruits.

Daily Requirements of Nutrients

For maintaining good health and physical efficiency, the diet should provide adequate amounts of nutrients. For designing balanced diets, it is essential to know the daily requirements of different nutrients. In order to prevent the ill effects due to deficiency of particular nutrients and to sustain a vigorous and healthy life, it is necessary to know in quantitative terms the amounts of the different nutrients needed. Obviously, this need will vary with the age, type of work and the dietary habits of the persons concerned. A schedule of dietary allowances will have to meet at least the minimum nutritional needs of the majority of persons for whom it is applied and at the same time provide reasonable margin to allow for physiological non-availability of some nutrients from particular foods. Such a schedule will help a group of persons to select the proper foods that will provide the nutrients in the amounts indicated. Also on a national level, such allowances will be useful in enabling governments to plan their food production policies, to judge the adequacy or otherwise of the national supply of foods, and to point to the areas in which improvement is called for.

Man needs more calories than woman. Calorie needs are higher with increased physical work. Protein allowance is same irrespective of work habit in man and woman. Water-soluble vitamins are involved in energy production and utilization. Because of this higher calorie/energy needs is accompanied by higher dietary vitamin needs. Dietary protein needs are higher for infant, children and adolescents due to additional need of protein for growth. Ca and Fe need are also more during growth. Calorie need is higher for moderately active man than that of moderately active woman, because higher body weight in man

Protein requirement per kg body weight is higher during growth period. Protein requirement per kg body weight for man and woman is same, but total protein requirement is higher for man than that of woman, because of higher body weight. For woman additional protein is needed in pregnancy and lactation. Only infant needs histidine. All essential amino acid requirements are higher in infants and children, i.e. during growth. Either human milk protein, 1.6g/kg or cow's milk protein, 2.0g/kg or egg protein, 1.6g/kg is sufficient to fulfill the minimal amino acid requirement for infant.

Requirement of most of the vitamins is less in woman than that for man. Woman needs less vitamins not due to active metabolism but due to lower body weight. No gender difference in mineral needs. Ca and Fe requirement is higher during growth. Woman needs more Fe than that of man due to physiological loss of iron in menstrual periods.

Nutrient Composition of Principal Food Crops

Cereals are the richest source of calories. Among Bajra, Maize, Rice and Wheat, Bajra is having higher caloric value (361 Kcal) due to high fat content. Cereals contain in addition, fair amount of protein and minerals. Pulses are the richest source of protein. Among pigeon pea, chickpea, pea, urd bean, mung bean and cowpea, pea is having higher average protein content followed by chickpea.

Oilseeds are the richest source of oil and fats; beside that, oilseeds are having good amount of protein, mineral, sugar and fibres. Among groundnut, sesamum, sunflower, soybean, safflower and rapeseed/mustard, groundnut is having higher amount of oil. The nutritive value of protein depends on its content of essential amino acids. Generally cereals are limiting in Lysine and Threonine, pulses are limiting in Sulphur-amino acids and Tryptophan, while oilseeds are limiting in Sulphur-amino acid, Lysine and Threonine.

Bajra is having higher content of tryptophan and leucine, wheat contain cysteine in higher amount and all other essential amino acids are higher in rice. Rice protein is the best quality protein. In pulses cowpea, black gram, pea and chickpea are good sources of amino acids as compared with other pulses. Oilseeds are limiting in Sulphur-amino acids, Lysine and Threonine. Soybean, sesame, rapeseed/mustard and groundnut are good sources of amino acids. Combination of cereals, pulses and oilseeds can compensate limiting amino acids of each group.

Results of Poor Nutrition

Due to poor nutrition different disease and problems of malnutrition occurred. Results of poor nutrients are:

1. Obesity
2. Heart Disease
3. Hypertension
4. Diabetes
5. Osteoporosis
6. Bones may break due to a lack of calcium
7. Gums may bleed due to low Vitamin C
8. Low Iron count.

New Trends

To overcome the disease occurred due to poor nutrition, we eat balanced diet. Food that we eat acts as a fuel to the body and provide essential nutrients, which further act as energy giving, structuring body and protect the body against diseases.

With changing time, the market consumption trend is also changing fast with a demand for better and healthier food. For increasing the nutritional quality of a food, new and novel ingredients are now being included in the product formulations. We eat nutraceuticals foods, a food or part of food or nutrient that provides health benefits, including the prevention and treatment of a disease.

Examples of Highly Nutritious Snacks

1. Peanut butter and jelly on wheat bread
2. Apples and peanut butter
3. Low fat yogurt
4. Cheese sticks
5. Granola / trail mixes
6. Turkey Roll-ups
7. Extruded snack foods.

We need to use technology for preparing nutraceuticals foods because at this time human has no time means busy to prepare foods. For fulfilling the daily requirement of nutrient, we can eat nutraceutical foods. One of them, Extrusion cooking is the technology that is used for enrichment of nutrient in snack food. Extrusion cooking technology has led to production of wide variety of products like pasta, breakfast cereals and snack foods etc. Now a day, human is becoming more and more health conscious thus incorporating of novel ingredients in extrusion cooking becoming necessary and it can enhance the nutritional value of the products.

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Organic Farming for a Better Future

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Vinodhini P.[1], Rajavarthini R.[2]

[1]Department of Agronomy, Imayam Institute of Agriculture and Technology, Tiruchirappalli District, Tamil Nadu, 621206.

Summary

In today's agricultural process, organic farming is highly sought-after. Organic farming is not only a convenient and environmentally safe method of farming, but also a modern one. A production approach known as "organic farming" forgoes or mainly forgoes the use of synthetically formulated fertilizers, herbicides, growth regulators, genetically modified organisms, and additives to livestock feed. Crop rotations, the use of crop residues, animal manures, legumes, green manures, off-farm organic wastes, biofertilizers, mechanical cultivation, mineral-bearing rocks, and elements of biological control are all utilized to the fullest extent possible in organic farming systems to maintain soil productivity and tilth, supply plant nutrients, and control insects, weeds, and other pests. The need for appropriate policies, increased public and private investments and technologies, knowledge and capacity building, based on sound ecosystem management, and harmony between organic farming and food security goals is therefore necessary to feed the world's hungry and poor and to ensure current and future food security.

Keywords: Organic, Nutrient Management, Limitations.

Introduction

A production approach known as "organic farming" forgoes or mainly forgoes the use of synthetically formulated fertilizers, herbicides, growth regulators, genetically modified organisms, and additives to livestock feed. Crop rotations, the use of crop residues, animal manures, legumes, green manures, off-farm organic wastes, biofertilizers, mechanical cultivation, mineral-bearing rocks, and elements of biological control are all utilized to the fullest extent possible in organic farming systems to maintain soil productivity and tilth, supply plant nutrients, and control insects, weeds, and other pests.

If organic farming practices organize themselves in production, certification, and marketing, they can boost farm productivity, repair decades of environmental harm, and connect small farm families to more sustainable distribution networks, improving food security. Over the past few years, a growing number of farmers have demonstrated a lack of enthusiasm in their work, and many who once farmed are moving to other regions.

One method of encouraging either self-sufficiency or food security is through organic gardening. The land and water are severely poisoned by the extensive use of hazardous pesticides and chemical fertilizers. This has serious environmental repercussions, such as topsoil loss, decreased soil fertility, contaminated surface and ground water, and genetic variety loss.

Need of Organic Farming

Our obligation would be to not only stabilize agricultural production but also raise it further in a sustainable way as a result of the population growth. The "Green Revolution," which used a lot of inputs, has plateaued, and is now being supported with dwindling dividends, according to scientists. To ensure the survival of life and property, a natural balance must therefore be preserved at all costs.

The obvious answer would be more pertinent now, since these agrochemicals are made from fossil fuels, are not renewable, and are becoming less and less available. Additionally, future foreign exchange losses could be significant.

Advantages of Organic Farming

1. By lowering the pollutant level, it contributes to maintaining environmental health.
2. It lowers the amount of residues in the product, lowering the risks to human and animal health.
3. It assists in maintaining agricultural production at a level that is sustainable.
4. It enhances soil health and lowers the cost of agricultural production.
5. It enables the best use of natural resources for immediate gain and aids in their preservation for future generations.
6. It not only minimizes the chance of crop failure but also conserves energy for both machines and animals.
7. It enhances the physical characteristics of the soil, such as granulation, good tilth, good aeration, easy root penetration, and enhances water-holding capacity while lowering erosion.
8. It enhances the soil's chemical properties, including nutrient supply and retention, nutrient loss into the environment and water bodies, and the promotion of favorable chemical interactions.

Nutrient Management in Organic Farming

Organic farming depends on creating a healthy soil that is full of organic matter and includes all the nutrients plants need. Several methods, such as green manuring, adding manures and biofertilizers, etc., can be used to improve soil fertility. In addition to providing the soil with diverse nutrients, these organic sources also help to suppress weeds and improve soil organic matter, which nourishes soil microorganisms. High quantities of organic matter in the soil promote water retention, stop soil erosion, and lessen the need for irrigation. Additionally, it is possible to improve the consistency of the soil by adding some natural minerals that plants need for growth. Lime is one of the soil additives used to alter the pH balance of the soil. However, the amount of heavy metals in water and soil amendment should be kept to a minimum. Most organic fertilizers are produced from repurposed waste leftovers from other industries. Farmers can also make compost by utilizing animal dung and mushroom compost. Before being applied to the fields, compost is heated and matured for at least two months, reaching and maintaining an internal temperature of 130°–140°F to kill undesired bacteria and weed seeds. A range of organic fertilizers, additives, and bacterial and fungal biofertilizers can be used in organic farming, depending on availability and crop suitability.

1. Organic manures: Farm yard manure (FYM), vermicompost, and other commonly used fertilizers are typically poor in nutrients, hence substantial application rates are necessary to meet crop nutritional needs. However, due in part to the country's substantial usage of cow dung in energy production, many developing nations, including India, do not have access to enough organic manures to meet crop needs. Sesbania, cowpea, green gram, and other green manures are very good at increasing the amount of organic matter in the soil. However, due to intense cropping and socioeconomic factors, the use of green manuring has decreased during the last few decades. Given these restrictions, the Codex Alimentarius and the International Federation of Organic Agriculture Movement (IFOAM) have authorized the use of some inorganic sources of plant nutrients, such as rock phosphate, basic slag, and rock salt.

2. Bacterial and fungal biofertilizers:

a. Rhizobium: It is well known that symbiotic N2 fixing bacteria, such as Rhizobia, are effective in promoting the growth of legume crops. Examples of these bacteria are Bradyrhizobium, Sinorhizobium, Azorhizobium, and Mesorhizobium. There is a worldwide spread of the bacteria that infects legumes. Depending on the host-plant species and bacterial strains, these rhizobia can fix up to 450 kg of nitrogen per hectare. For the purpose of introducing certain bacterial strains into soil, carrier-based inoculants can be coated on seedlings.

b. Azotobacter: Symbiotic or not, free-living N2 fixing bacteria can fix atmospheric nitrogen in cereal crops. These free-living bacteria include Acetobacter diazotrophicus and Herbaspirillum spp. for sugarcane, sorghum, and maize crops, as well as Azotobacter sp. for various cereal crops. In addition to fixing nitrogen, they also boost young plants' vigor and germination, which improves crop stand. They may annually fix 15–20 kg/ha of nitrogen. Azotobacter sp. can also create antifungal chemicals to fight off a variety of plant diseases. Azotobacter is also capable of biologically controlling plant nematode infections.

c. Azospirillum: A range of annual and perennial plants are colonized by this genus. Azospirillum may be able to boost the growth of crops like sunflower, carrot, oak, sugarbeet, tomato, pepper, cotton, wheat, and rice, according to studies. Crop yield might rise by 5% to 30%. Azotobacter and Azospirillum inoculum can be created and applied through seed coating just like in peat formulation. The peat formulation can also be applied directly in the field.

d. Phosphorus-solubilizing bacteria (PSB): Next to nitrogen, phosphorus is an essential nutrient for plants and microbes. Azolla and BGA, two nitrogen fixers, as well as Rhizobium need this element to nodulate. The phospho microorganism, primarily bacteria and fungus, supply the plants with insoluble phosphorus. It can raise crop output by up to 200–500 kg/ha, saving 30–50 kg of superphosphate. The genera Bacillus and Pseudomonas contain the majority of the phosphorus-solubilizing bacteria (PSB). The most popular biofertilizer in India right now is PSB. PSB can cut a crop's P demand by up to 25%.

e. Azolla: The nitrogen-fixing BGA Anabaena azollae is housed in the 'Azolla' floating water fern. Azolla increases soil organic matter and contains 3.4% nitrogen (on a dry weight basis). Rice farming makes use of this biofertilizer. There are six different species of azolla, including azolla caroliniana, azolla nilotica, azolla mexicana, azolla filiculoides, azolla microphylla, and azolla pinnata. The azolla plant has genuine roots that reach deep into the water, a floating, branching stem, and deeply lobed leaves. On the stalk, the leaves are positioned alternately. There are ventral and dorsal lobes on every leaf. Chlorophyll is present in the fleshy dorsal lobe, which is open to the atmosphere. In ditches and still water, it thrives. If water is not a constraint and the climate is favorable for its development, azolla can be easily grown all year round in India. Over water, this fern typically creates a green mat. Azolla quickly breaks down into NH4, which the rice plants can use. According to field tests, using Azolla enhanced rice yields by 0.5-2 t/ha. Azolla application has been credited with an increase in rice yield of roughly 20% and 18% in India and China, respectively.

Weed Management in Organic Farming

Herbicides made of chemicals are prohibited in organic farming. Therefore, weeding can only be done by hand. Numerous cultural practices, including tillage, flooding, and mulching, can be used to suppress weeds. To control loss caused by weeds, biological (pathogen) approaches can also be used. On fallow land, a cover crop can be planted to reduce weed growth and enhance soil quality. It can also aid in reducing the growth of weeds to use drip irrigation, which restricts the flow of water to the plant line.

Limitations and Implications of Organic Farming

1. If organic inputs are obtained, organic manure may cost more per plant nutrient than chemical fertilizers since it is less widely available.

2. The typical Indian farmer cannot comprehend the regulations for organic cultivation, processing, shipping, and certification, among other things.

3. Organic farmers should receive higher rates for their produce because production drops in the early years of their business.

Conclusion

Chemical fertilizers and pesticides are rarely used in dry plains, which make up over 65% of India's arable land. As a result, many regions are at least "relatively organic" or "organic by default," and some of these lands can be quickly converted to organic farming for higher yields and returns. The need for appropriate policies, increased public and private investments and technologies, knowledge and capacity building, based on sound ecosystem management, and harmony between organic farming and food security goals is therefore necessary to feed the world's hungry and poor and to ensure current and future food security.

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A Review Study on Backyard Poultry Farming: An Important Livelihood Source of Indian Farmers

Article ID: 40634

Anita Meena[1], Kesar Chayal[2]
[1]Ex. M.Sc. Student, Department of Home Science, University of Rajasthan, Jaipur.
[2]Assistant Professor,Department of Home Science, University of Rajasthan, Jaipur.

Introduction

Small poultry are part of farming systems run mostly by women farmers in rural areas. Livestock and poultry are major contributors to the Indian economy (Nath et al, 2012). In countryside poultry farming makes an important contribution role especially for socio-economic development weaker sections of society in the state Meghalaya. Generates self-employment, provides additional intake and protein-rich food supplements at a relatively low price. In this part of the country, Poultry farming is a traditional practice among indigenous people with local breeds. There is a huge base for poultry farming in rural meat which they make up about 85 percent of the total population. Poultry farming also helps in generating income unemployed rural youth and women (Padhi, 2016). Backyard or homestead poultry farming is common among rural and landless families in India and is a lucrative source of supplementary income. It involves low investment and brings high economic returns and can be easily managed by women, children and the elderly. The meat and eggs of these birds are a cheap and abundant source of protein and energy for poor households. Backyard poultry farming is characterized by an indigenous system of night shelters, housekeeping, natural hatching of chickens, low bird productivity, insufficient supplementary feed, local marketing and minimal health care practices Singh (2021).

The major challenge with local birds is low egg production and less weight gain. These breeds need to be replaced by superior breeds phenotypically similar to existing poultry population. Height profitable layers and broilers cannot survive under suboptimal nutritional and management status in a stressful environment. It is a dual purpose chicken variety developed by the company Directorate of Poultry Project in Hyderabad which it is suitable for rural communities and can be farmed when feeding in the backyard mainly from wild catches food with minimal supplements. It grows faster and produces more eggs than the available Desi variety of poultry. Additional income less care will provide economic support to farmers. Birds can be raised with less investment and less technical. Promotion of backyard poultry farming with new poultry varieties could help to substitute the loss due to crop failure to some extent. Hence a study was conducted.

The organized or commercial poultry sector in India contributes nearly 75% of the total meat and egg output while the unorganized sector contributes 25%. According to the 20th Livestock Census reports of the Government of India, total poultry population is 851.81 million (including backyard poultry population of 317.07 million), which is a 45.8% rise over previous livestock censuses (http://www.dahd.nic.in/division/provisional-key-results-20th-livestock-census). Egg production in India was around 95.2 billion and per capita availability (PCA) around 74 per annum during 2017-18 (http://www.dahd.nic.in/documents/reports).

Importance of Backyard Poultry Farming

1. Bonuses of backyard poultry farming
2. A source of employment to small and marginal farmers, including women and unemployed youth
3. Provides additional income
4. Enhances soil fertility (15 chickens produce 1-1.2 kg of manure/day).
5. Products fetch a higher price compared to those from commercial poultry farming
6. Egg and meat with low investment
7. Eggs and meat contain low levels of cholesterol and saturated fats and high levels of vitamin compared to meat from commercial poultry
8. Helps control ecto-parasites in domestic animals

9. Accessible source of nutrition for families.

Materials and Methods

Research methodology is partly descriptive and exploratory. For this study data and information has been collected with the help of secondary sources like academic journals, government publications, research journals, e-journals, various reports, books, bulletins online repositories.

Results and Discussion

Research Findings Related to Backyard Poultry Farming: In this section concluded different research studies results for supported this review study. Bhattacharjya, R et al., (2020).

Table 1. Correlation of the independent variables with the knowledge gained and adoption of improved backyard poultry rearing.

Sr. No.	Independent variable	Correlation coefficient	
		Knowledge gained	Adoption
	Age	0.0154	-0.0242
	Educational status	0.1987*	0.0664
	Land holding	-0.0414	0.0077

*Significant at the 1% level of probability

Pearson's test was employed. It was observed that only educational status was positively correlated with the knowledge gained. All other variables were none significantly correlated with knowledge and adoption of backyard poultry farming. Accordingly, Ondersteijn et al (2003) observed that education level was one of the main factors that improved the performance of dairy production. Similarly, Andreakos et al (1997) and Wilson et al (2001) stated that the education level has a substantial effect on the financial performance of agricultural activities.

It was inferred that difficulty in availability of inputs like feeds, medicines etc. followed by less knowledge about new and improved breeds and poor availability of quality chicks are some of the critical constraints faced by the respondents.

Table 2. Constraints faced as perceived by the respondents for rearing improved backyard poultry.

Sr. No.	Constraint	Rank
1	Difficulty in availability of inputs like feeds, medicines etc.	I
2	Less knowledge about new and improved breeds	II
3	Poor availability of quality chicks	III
4	Disease outbreak and mortality	IV
5	Not taking it commercially	V
6	Absence of structured market system	VI
7	Poor acceptability by the consumers	VII

Finger Tips Suggestion for Backyard Poultry Farming

1. Disease free, improved strain, dual purpose poultry birds may be procured for back yard poultry farming.
2. Periodical vaccination should be done on regular basis.
3. Clean drinking water and fungus free feed should be supplied to the birds.
4. The poultry shed should be regularly cleaned and free from moisture and humid condition.
5. Overcrowding should be avoided.
6. If possible, there should be separate space for different age group of birds.
7. Sick bird should be immediately separated/ culled from healthy flock.
8. Poultry equipment particularly watered and feeder should be regularly cleaned and disinfected.
9. There should be restriction for outsider into the poultry shed or farm.
10. The birds should be free from predators and should not be scared by other animals.

Conclusion

Most of the farmers are at a young age and they are very passionate about breeding the Vanaraja breed poultry as backyard. The only downside is availability of inputs such as quality chickens, feed and medicines etc. without knowledge of new a improved breeds and a structured market. Backyard poultry production is an age-old practice in rural India. Most of the backyard poultry production comprises rearing of indigenous birds with poor production performances. The potentiality of indigenous birds in terms of egg production is only 70 to 80 eggs/ bird/ year and meat production are also very less. However, the backyard poultry production can be easily boost up with improved varieties of chicken and can promise a better production of meat and egg. To improve the socio-economic status of the traditional farmers, backyard poultry is a handy enterprise with low-cost initial investment, but high economic return along with guarantee for improving protein deficiency among the poor.

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Potential Benefits of Cow Pea

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Dr. R. Neela Rani[1], Dr. B. Spandana[2], Dr. T. Asha Jyothi[3]
Principal Scientist[1], Young Professional-II[2], Senior Scientist[3]
Extension Education component. All India Coordinated Research Project on Women In Agriculture, Professor Jayashankar Telangana State Agricultural University, Hyderabad, Telangana, India.

Cowpea is an intercropping crop during Kharif and Rabi seasons. It is also known as southern pea, cow gram, Macassar bean, niebe, crowder pea and in the Indian subcontinent as in Hindi chawli or lobia, in Telugu bobbarlu or alachandalu, in Kannada alasande, in Tamil karamani payir, in Malayalam vanpayar and in Bengali barbate. It is cultivated widely in the dry regions across Africa and Asia. It is mostly used as pulse. It belongs to the food legume of the family Fabaceae/Papilionaceae. The tender pods are made as a vegetable. Cowpea flowers and leaves also used as edibles in some parts of the world. It is an excellent fodder and excellent manure for cattle. It is high in protein, iron and zinc. Apart from that, they are high in fiber and fatty acids. High protein, carbohydrates, low fat and a complementary amino acid pattern makes cowpea an important nutritional food. Cowpea is the major source of food for millions people mainly in developing countries with an annual worldwide production of about 4.5 million metric tons. Studies shows that regular consumption of cowpeas reduces LDL and total cholesterol levels and improves blood circulation and heart health.

Making raw cowpeas into pulses increases the taste and digestibility. Reduces cooking time. Cowpeas can be soaked overnight and boiled in the morning. Vitamins are also more available if sprouted cowpeas are used.

Cowpea Nutritive Values Per 100g

Nutrients	Nutritive values	
	Cowpea, brown (Vigna catjang)	Cowpea, white (Vigna catjang)
Energy (KJ)	1340±7	1340
Carbohydrates (g)	54.62±0.49	53.77
Protein (g)	20.36±0.59	21.25
Fat (g)	1.15±0.06	1.14
Iron (mg)	5.90±1.26	5.04
Calcium (mg)	81.73±7.63	84.10
Magnesium (mg)	213±20.3	213
Potassium (mg)	1241±116	1243
Zinc	3.41±0.41	3.57

Vitamin B1 (mg)	0.33±0.087	0.34
Vitamin B2 (mg)	0.09±0.009	0.09
Vitamin B3 (mg)	1.64±0.03	1.51
Vitamin B5 (mg)	1.47±0.31	1.66
Vitamin B7 (mg)	3.97±0.12	4.28
Vitamin B9 (µg)	231±27.3	249

Source: NIN, Hyderabad KJ: Kilo joules, g: grams, mg: milli grams, µg: micro grams.

Benefits

Cowpeas supports weight loss: Due to high protein content and soluble fiber, it is a great way to boost weight loss.

Promote digestive health: The soluble fibers enhance beneficial gut bacteria and improve digestion.

Enhance heart health: regular consumption of cowpeas can lower LDL cholesterol and lower markers of inflammation this helps to reduce several risk factors of heart disease.

Manages Diabetes: due to low glycemic index, it regulates the blood glucose levels.

Enhances Skin Health: cowpeas are excellent sources of protein, zinc, vitamins A and C and supports collagen synthesis and accelerates the process of skin repair and formation of new skin cells.

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Agricultural Diversification and its Benefits

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Keisham Dony Devi[1], Manoharmayum Monica Devi[2]
[1]Department of Agronomy, College of Agriculture, CAU, Imphal.
[2]Department of Soil Science and Agricultural Chemistry, College of Agriculture, CAU, Imphal.

Agriculture is the backbone of Indian economy with almost 60% of the country's population living in the rural areas, agriculture is their main occupation. Apart from supply of food demands, agriculture is also an important source of raw materials for the manufacturing industry such as fertilizer industry, pesticides and implements. Therefore, rural upliftment and development of farmer's socio-economic condition is very much important to bring overall growth in the country. Mostly, monocropping is prevalent in Indian agriculture with very less to no diversification. Farmers would plant main crops like rice, wheat or maize and leave the fields fallow in the following season. Even though some farmers would plant vegetables and other crops, the comparative area is extremely less and it is mainly for subsistence purposes. Moreover, dominance of the wheat-paddy cropping system has led to serious economic, social and ecological problems, such as deceleration in productivity growth, drop in agricultural self-employment, over exploitation of ground water resources and decline in soil fertility (Chand, 1999). This leads to no source of extra income for the farmers and in case of drought or crop failures, the farmers are left with no choice but to suffer by themselves. Due to these reasons, there is very less growth in the Indian agriculture scenario with very less diversification. Also, Jorge and Valdes (1995) stated that as we have witnessed quite a high number of farmer suicides in many parts of India, diversification of the crop mix can be an efficient mechanism for diminishing the impact of risk on farmers' welfare. Therefore, alternative production systems or opportunities that can generate new employment, growth and enhance income is the need of the hour (Barghouti *et al*., 2004).

According to Chand (1999), agricultural diversification indicates the changes in crop-mix, enterprises-mix and activity-mix at household level. It is considered a shift of resources from monoculture to a large mix of crops and livestock. Others define it as a change in cropping pattern or the farmers opting for other non-farming options like poultry farming, animal husbandry, etc. This practice allows farmers to expand the production, which helps generate a higher level of income. Diversification, within the agriculture sector is a shift from the cropping pattern of less remunerative crops to a highly value-added diversified type of agriculture. In other words, it involves changes in the production portfolio from a low-value to high value commodities like vegetables, milk, meat, eggs and fish based on the market demand that creates the new horizon for the rural income source (IFPRI, 2007).

Agricultural diversification may include four stages:
1. Shift from mono cropping to multi cropping
2. Addition of more than one enterprise like poultry, fishery, piggery, etc.
3. Initiation of mixed farming
4. Value addition of the different farm produce through processing, packaging, etc.

On type of expansion, agricultural diversification can also be divided into the following two types:

1. Horizontal Diversification: It basically includes the shifting of a single cropping system to multiple cropping systems. It is also known as diversification of crop production.

2. Vertical Diversification: When a farmer shifts the agriculture farming sector to non-farming or another workforce then it is known as Vertical Diversification. It is also referred to as diversification of productive activities.

Benefits of Agricultural Diversification

Advantages of diversification can be measured in terms of increased profitability, more employment opportunities and better resource management. On the other hand, agriculture can be looked upon as a combination of crop production, processing or value addition, marketing and linking of supply and demand chains. Therefore, diversification can be used to compress the supply chains, strengthen the linkages and bring about better returns. Some of its benefits include:

1. Better utilization of land, labor and capital: In managing only one enterprise, suppose in case of monocropping, only a portion of the resource like nutrients, water, etc will be used for production and then after the economic part of the crop has been harvested, the non-economic part like straw or stalks will become farm waste. This waste could have been used as an input or raw material in another enterprise like livestock or fisheries if the farmer was managing more than one enterprise. This way the nutrients will be recycled along with practicing sustainability. Therefore, agricultural diversification tends bring about efficient resource utilization.

2. More employment opportunities and security: When farm produce are converted into value added commodities, labors or workforce will be needed as they are labor-intensive process, this will create more employment opportunities especially in rural areas. It will provide rural households with a long term economic stability as farmers and labors will be engaged all year round in different activities. The advantage of higher employment opportunities are expected to benefit smallholders more as they possess more family labor (Joshi *et al*., 2003).

3. Reduces poverty and increase income level: By branching out and management of more than one enterprise, the number of sources of revenue increases which ensures that the farmer is less susceptible to loss of investment due to failure of one enterprise. This is beneficial especially for increasing the level of income of smallholder farmer. A study on economics of shrimp farming in Andhra Pradesh reported up to 8-13 times higher returns from shrimp farming than paddy and groundnut crops depending on the variety (Ratna *et al.,* 2004). Studies from many developing countries have also shown that agricultural diversification towards high value commodities augment income of rural poor (Joachim, 1995; Joshi *et al.,* 2004).

4. Reduce risk in agricultural sector: As there is more than one source of revenue in a diversified farm, failure of one enterprise will have very less adverse impact on the economics of the farm. Also, there will be less risk to market price fluctuations, crop failures, natural calamities or climate fluctuations.

5. Sustainable use of natural resources: Agricultural diversification is beneficial for resource conservation and maintaining natural diversity which is often lost when an area of land turns into an agricultural farm. Diversification of farm is most beneficial in maintaining the ecological diversity. As a wide variety of crops and animals will be managed in the farm, their genetic diversity will be automatically conserved especially the local varieties. This conservation will be most beneficial for a sustainable type of agricultural production and act as a gene pool for future generations.

Conclusion

Agricultural diversification towards high-value selective cash crops like vegetables and fruits, compatible with the region which gives comparative advantage, is suggested as a viable solution to arise and stabilize farm incomes, increase employment opportunities for small and marginal farmers, increase exports and conserve and enhance the natural resource base, principally land and water (Rao *et al*., 2006; Sharma, 2005). It is safe to add that agricultural diversification is mainly triggered by improved rural infrastructure, changing food demand patterns and rapid advancements in agricultural food productions. Hence, it is likely to overall trigger acceleration in agricultural growth and usher in a new age of rural entrepreneurship. According to Lone (2013), there appears immense scope for diversification of agriculture towards high-value commodities especially in India.

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Financial Services in Agriculture Sector

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Shokila C[1], Rohini A[2]

[1]Ph.D. Scholar, Department of Agricultural and Rural Development, Centre of Agricultural and Rural Development Studies, Tamil Nadu Agricultural University, Coimbatore – 641003.

[2]Professor (ARM), Department of Agricultural and Rural Development, Centre of Agricultural and Rural Development Studies, Tamil Nadu Agricultural University, Coimbatore – 641003.

Introduction

Access to finance is critical for the growth of the agriculture sector. The shift from subsistence to commercial agricultural production requires funds. The shift from subsistence to commercial agricultural production requires funds. Financial institutions are reluctant to accept the risks prevalent in the agricultural sector, such as droughts, floods, pests and diseases, or the transaction costs of covering large geographical distances. Consequently, although governments are now making efforts to attract investment for agriculture, the lack of understanding of the financial risks and opportunities in agriculture, deprives the sector of much-needed funds to boost production, processing and marketing.

Who Needs Finance in the Agriculture Sector?

1. The needs of farmers and entrepreneurs,
2. The transactions between the actors along the value chain,
3. Infrastructure needs,
4. Generating knowledge to support the sector.

Inclusive Finance (or Micro-Finance)

This instrument is slightly more sophisticated but still part of the informal financial sector. It is referred to as inclusive finance or micro-finance and has grown considerably in the last decade. The goal is to "expand access to affordable and responsible financial products and services by poor and vulnerable populations".

Credit Guarantee Schemes

This instrument also improves the chances for access to finance. These schemes "provide guarantees to groups that do not have access to credit by covering a share of the default risk of the loan. In case of default, the lender recovers the value of the guarantee".

Value-Chain Finance

1. Internal finance: This takes place between participants along the value chain based on their relationships, such as when a fertilizer company provides fertilizers and the farmer only pays the company after they have sold their harvest. This approach includes product financing, trade credits, input-supplier credits, marketing company credit and lead firm credits.

2. External finance: This comes from outside the value chain—for example, a microcredit bank will cover the costs of purchasing the fertilizer for the farmer.

Leasing and Factoring

Leasing is used to finance machinery, automobiles and equipment in agriculture. Factoring is when a company sells its invoices to a third party (the factor) at a discount in order to improve cash flow. These mechanisms aim to reduce some of the traditional lending risks of agriculture. They are an alternative option for borrowers with limited collateral and credit history, to be able to rent machinery, equipment and other assets related to production.

Financing for R&D

Innovation and knowledge are other critical areas that need financing. R&D has resulted in numerous innovations for agriculture. EMBRAPA, for example, a state-owned company that coordinates the national agricultural research system in Brazil, has developed more than 9,000 technologies in Brazil. It relies primarily on public financing because of its public aim to provide innovative knowledge for the sector as a whole.

Challenges of Agricultural Financing

1. Transaction costs in rural areas are higher than in urban areas due to a more dispersed population with weak infrastructure.
2. The risk factors inherent in agriculture often inhibit financial institutions from lending. These include production risks linked to natural hazards (such as droughts, floods and pests), farmers´ weak ability to provide collateral (either because the farmer lacks title to land to offer as a loan guarantee or the value of the land may be too low) and the volatility of prices.
3. The availability and innovation on sector-specific financial instruments and services is usually poor. Also, although financial services may be available, they may not be suitable for all types of agricultural activities, which will have diverse needs with respect to timing for disbursements, amounts and risks, among others.
4. The lack of records and statistics on farming in developing countries makes assessment of credit suitability challenging for financial providers. This changes the conditions required to access financial products and undermines opportunities for profitable investment.

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Do Insects Really Sleep?

Article ID: 40638

Ipsita Ghosh[1], Pranab Debnath[2]
[1]Ph.D scholar, [2]Assistant Professor,
Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India.

Introduction

Sleep is an important component of every living organism's daily routine. In mammals and insects, it is essential for proper brain function. Animals are isolated from the outer world during sleeping. It helps us to restore and rejuvenate. Without it, our minds aren't as sharp, and our reflexes become dull. Birds, reptiles, and other mammals all exhibit resting brain wave patterns that are identical to those of humans, according to scientific research. But, What about insects, though? It's not always clear to us whether insects sleep similarly to us. They don't have eyelids, so you'll never see a bug close its eyes for a little nap.

Importance of Sleep in Insects

For invertebrates, especially insects, sleep is crucial. It is needed for retention of extinction learning and precise communication, for basic survival and for Protection against predators. Sleep deprivation at night diminishes the accuracy of waggle dance signalling in honey bees (*Apis mellifera*) and lowers the likelihood of successfully returning to the hive the following day. In fruit flies *(Drosophila melanogaster*), sleep deprivation causes short- and long-term memory defects.

Insect Sleep

Sleep-like states was described in 1912 for different insects like bees (Apidae), wasps (Vespidae), moths (Pyralidae), mosquitos (Culicidae), and cockroaches (Blattoidae). As demonstrated by many hymenopteran species, cockroaches (Blattidae), and flies (Drosophilidae), all these arthropods explicitly select sleeping locations and adopt particular sleeping positions. Also, the orientation of honey bees' antennae provides a clear indication that they are sleeping.

Torpor in Insects

The word 'torpor' was derived from the Latin word 'torpere' which means "to be numb or sluggish". This term "torpor" is used to represent insect sleep which is different from sleep in human beings. It is a sleep-like phase with reduced physiological activity, body temperature, and metabolic rate. It is controlled by two major factors namely the circadian clock and homeostasis. circadian clock plays a crucial role in the timing and consolidation of sleeplessness and nap whereas homeostasis reflects the requirement of sleep that cumulates during the course of sleeplessness or wakefulness and disappears during sleep.

Sleep Like State in Different Insects

When Insects are yet to enter the torpor state, they look for a comfortable site, which are usually undisturbed by other living organisms, predators.

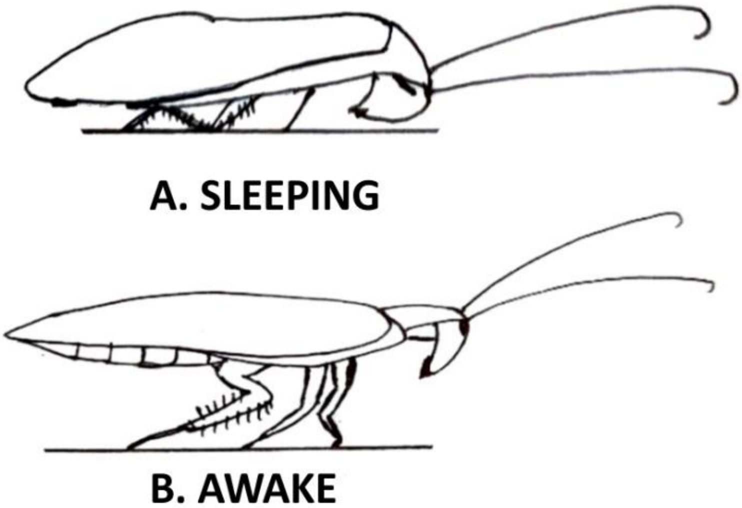
Research on the torpor or sleep-like condition in D. melanogaster was carried out. Torpor in *D. melanogaster* was investigated using a standard locomotor assay, in which the flies were examined and recorded individually over the course of 48 hours using a CCTV camera. The data gathered during the inquiry period showed proof of Drosophila fly preference for location and immobility for up to 157 minutes at a specific point in the circadian day. The total sleeping period for female flies was 400 to 800 min/day, whereas in case of males it was almost 1100 min/day.

Cockroaches also show signs of sleep. When cockroaches fold their antennae, they are in a resting state. They also show a decrease in their susceptibility to outside stimuli while they are sleeping. Cockroaches are often up and active for the first four hours after lights off. They take their cues from when people typically turn out all the lights at night, leaving them with four hours of uninterrupted work to do all of their primary tasks.

While migrating to the south at night, monarch butterflies typically form a cluster of groups (congregate) and fold their wings. Before the journey the following day, they seem to be lifeless. An additional advantage of sleeping in a clumped pattern is that their sleeping aggregation keeps them safe from predators.

Sleep in bugs are indicated by 'not moving, drooping in the direction of gravity and more relaxed muscles'.

In honeybees *Apis mellifera* (Hymenoptera: Apidae) formation of memory remains unaffected by sleep. Retention of extinction learning is significantly reduced in the bees that were sleep-deprived. Some bees of family Apidae (mostly males) clamp onto a plant with their jaws in the evening and stay in that position till the next morning.

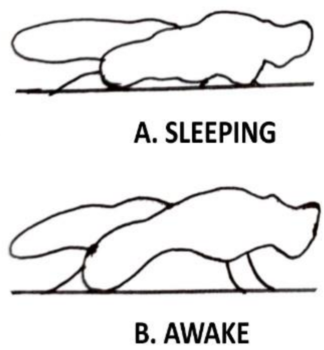


Different posture in cockroach A. Sleeping, B. Awake

Sleeping posture of honey bee

Sleeping posture of bug

Monarch butterflies sleeping in cluster



Different posture in fruit fly A. Sleeping, B. Awake

Sleep Deprivation in Insects

Certain insects frequently exhibit the physiological behaviour of sleep deprivation. It happens when insects are not given enough time to rest or sleep properly while living in unfavourable conditions that have been artificially generated in their habitats.

Sleep deprived honeybees show reduced foraging activity. They fail to communicate with other nest members via waggle dance resulting in gradual loss of fitness of bee colonies. In fruit flies *(Drosophila melanogaster*), sleep deprivation causes short- and long-term memory defects.

Sleep Rebound

Sleep rebound is an important part of insect lives especially after certain sleep deprivation; sleep rebound is crucial in getting back to their normal livelihood. Although there hasn't been much research on sleep rebound to yet, several authors have offered data or observations on specific insect species. After a prolonged period of sleep deprivation, honey bees *A. mellifera* must engage in a recovery sleep or sleep rebound. Honey bees restore their lost communication skills (due to sleep deprivation) and communicate with their nest mates through the waggle dance once more as a result of sleep recovery.

Conclusion

Although much study and several contributions have been done, insect sleep is still in a fascinating and little-understood state. To understand more, sleep and circadian cycles can be investigated in extremely simple organisms like fruit flies or bees. Insect pests may also be managed by interfering with their circadian rhythms. We can anticipate better control by taking advantage of the pest's weakest stage and applying pesticides when they are most effective since circadian rhythms affect insect metabolism.

Mimicry in Insects

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Ipsita Ghosh[1], Pranab Debnath[2]
[1]Ph.D scholar, [2]Assistant Professor,
Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India.

Introduction

The concept of mimicry was first given by H.W. Bates in 1862. Mimicry is a phenomenon in which one organism resembles another organism's physical and/or behavioral traits to receive a selective advantage. It is very much common in insects. In most of the mimetic relationships, the advantage is one-sided, with one species (the mimic) gaining advantage from a resemblance to the other (the model). Although, in many cases organisms involved in mimicry belong to the same class, order, or even family, but there are many documented cases of both plants and animals imitating one another. Most well-known instances of mimicry involve physical likeness, research has shown intriguing circumstances in which the similarity involves sound, scent, behaviour, and even biochemistry.

Mimicry can be inter- or intraspecific, occurring between individuals within the same species or between different species. Mimicry is often the consequence of a natural selective pressure that benefits an evolutionary advantage in a population of one organism, and over time, frequently within the same environmental context, a second creature evolves to display comparable qualities that improve its environmental adaptation. Deception is one of the adaptive advantages granted to the secondary organism. By imitating the first creature, the secondary organism can deceive predators, prey, and even partners.

	
***Ophrys apifera* (Bee orchid) mimicking bee**	**Satanic leaf-tailed gecko (lizard) mimicking leaf**

Different Types of Mimicry

1. Protective mimicry: Protective mimicry provides protection to the mimic. When an organism uses concealing mimicry, it either looks for a background that matches its colour or modifies its colouring to blend in. such as the walking stick bug.

Walking stick resembles surronding

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2. Aggressive mimicry: A predator or parasite species may mimic less dangerous animals or objects to get access to a host or to mate. Example: Fire flies, spiders, etc.

A female *Photuris versicolor* firefly that has captured and is feeding on a male *Photinus tanytoxus* firefly by mimicking female *P. tanytoxus* flash signals.

3. Mullerian mimicry: Mullerian mimicry is the similarity of two or more noxious or dangerous species. Fritz Muller made the discovery of Mullerian mimicry. For example, Cuckoo bee with yellow jacket wasp.

	
Cuckoo bee	**Yellow jacket wasp**

4. Batesian mimicry: It is a type of protective mimicry in which predators stay away from an edible or harmless species because it closely resembles an inedible or destructive species. Examples are the Viceroy and Monarch butterflies. Viceroy butterflies may be eaten, while Monarch butterflies cannot.

	
Viceroy butterfly (harmless and edible)	**Monarch butterfly (harmful and nonedible)**

5. Automimicry: It is also known as intraspecific mimicry, is the act of an animal imitating specific features of its own body within a single species. Ex: The "false head" of the common tit butterfly deceives predators.

False head of tit butterfly

Cryptic Coloration and Camouflage

Cryptic coloration is a type of camouflage. In order to evade predators by appearing to be a natural part of their habitat, insects employ a variety of colours, patterns, and textures to blend in with their surroundings. As an alternative, an organism can ambush prey by blending into the surroundings, concealing from view, and waiting for its unwary prey. Examples include preying mantids that are green or brown in colour, blending in with the leaves of the plants they are surrounded by, and the Flower Preying Mantis, which resembles an orchid flower. It draws prey by using its camouflage as a hunting tool. It has been demonstrated that many insect pollinators are drawn to the pink coloured Flower Mantis that is laying in wait.

In an effort to avoid detection, both predators and prey adopt cryptic coloration as well as a variety of other morphological and behavioural adaptations. Predators use camouflage to remain undetected as they lie in wait to ambush unaware prey, while many prey organisms try to hide from predators using camouflage.

	
Camouflage in Preying mantid	**Flower mantid resembling orchid flower**

Chat GPT: Pioneering a New Era of Sustainable Agriculture

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Ram Mohan[1], Reshma. R[2]

[1]Ph. D. Scholar, Division of Plant Pathology, ICAR- Indian Agricultural Research Institute, New Delhi-110012.

[2]Ph.D. Scholar, Division of Entomology- ICAR- Indian Agricultural Research Institute, New Delhi-110012.

Introduction

The agricultural sector has come a long way since the first farms were established thousands of years ago. Today, with the help of technology, farmers are able to produce more food than ever before. And with the emergence of artificial intelligence (AI), agriculture is poised to undergo yet another revolution. One such AI technology that is making waves in the field of agriculture is Chat GPT. Chat GPT (Generative Pre-trained Transformer) is a language model developed by OpenAI. It is designed to generate human-like text in response to a given prompt. Chat GPT has been trained on a massive amount of text data, which has allowed it to learn about the nuances of human language and communication. The power of Chat GPT lies in its ability to analyze and understand agricultural data. With the help of Chat GPT, farmers can now process large amounts of data related to weather patterns, crop yields, and soil conditions, among other things.

Revolutionizing Agriculture through Chat GPT

One of the key ways in which Chat GPT is revolutionizing agriculture is through its data analysis capabilities. Chat GPT can help farmers make more informed decisions about their farming practices by analyzing vast amounts of data. For example, Chat GPT can be used to predict weather patterns and help farmers determine the best time to plant their crops. It can also be used to identify soil conditions that are conducive to certain crops and help farmers select the most appropriate crops for their fields. Chat GPT can also be used to analyze historical data and identify trends that can inform farmers' decision-making. For instance, Chat GPT can be trained on historical data related to crop yields and soil conditions to identify the optimal planting strategies for different crops in different regions. This can help farmers decide which crops to plant, how much to plant, and when to plant them.

Another way in which Chat GPT is revolutionizing agriculture is through its chatbot feature. Chat GPT can be integrated with chatbots, computer programs designed to simulate human conversation. Farmers can use these chatbots to ask questions about farming practices, soil conditions, and other agricultural issues. The chatbots can provide real-time answers based on the data that has been analyzed by Chat GPT. Chatbots are particularly useful for farmers who do not have easy access to agricultural experts or who may not have the expertise to interpret complex data. By using chatbots, farmers can get answers to their questions quickly and easily. This can help them make more informed decisions about their farming practices and improve their yields.

Moreover, Chat GPT can be used to develop personalized farming plans for individual farmers. By analyzing data about a particular farm and its conditions, Chat GPT can provide customized recommendations for crop selection, fertilizer application, and other farming practices. This can help farmers optimize their yields and reduce waste.

In addition, Chat GPT can also help farmers monitor their crops in real time. By analyzing data from sensors and other sources, Chat GPT can provide farmers with real-time alerts about changes in weather patterns, soil conditions, and other factors that may affect their crops. This can help farmers take proactive steps to protect their crops and maximize their yields.

Chat GPT has the potential to revolutionize the field of agriculture. Its ability to analyze large amounts of data and make informed recommendations can help farmers optimize their yields, reduce waste, and improve their overall productivity. And with the continued development of AI and machine learning technologies, the potential applications of Chat GPT in agriculture are only just beginning to be explored.

Another area where Chat GPT is making an impact in agriculture is crop breeding. Traditionally, crop breeding has been a time-consuming and resource-intensive process. However, with the help of Chat GPT, the process can be accelerated and made more efficient.

By analyzing genetic data and other relevant data points, Chat GPT can help identify the most promising genetic combinations for developing new crop varieties. This can save researchers time and resources, and lead to the development of new crop varieties that are better suited to specific growing conditions.

Furthermore, Chat GPT can also help improve the quality of existing crop varieties. By analyzing data on soil conditions, climate, and other factors, Chat GPT can provide recommendations for improving the quality and yield of existing crops. This can help farmers produce higher quality crops, which can in turn lead to higher profits.

Impact of Language Models in Agriculture

1. Predictive analytics: ChatGPT can be trained to analyze large amounts of data from various sources to inform crop and livestock management decisions. This can help farmers optimize their operations, increase yields, and reduce costs.

2. Crop and livestock monitoring: ChatGPT can be used to monitor crops and livestock using sensors and cameras. This can help farmers detect early signs of disease or stress, allowing them to take proactive measures to address the issue.

3. Automation of manual tasks: ChatGPT can be used to automate manual tasks such as planting, harvesting, and monitoring crop growth. This can help farmers save time and labor costs, and reduce the risk of human error.

4. Smart irrigation: ChatGPT can be used to optimize irrigation systems, for example by using weather data to predict when and how much water to apply to crops.

5. Precision agriculture: ChatGPT can be used to analyze data from various sources, such as weather reports, soil samples, and market prices, to inform precision agriculture techniques. This can help farmers make more informed decisions about planting, fertilization, and crop protection.

Disadvantages

Chat GPT is a powerful AI technology that has the potential to revolutionize many fields, including language processing, education, healthcare, and agriculture. Of course, like any technology, Chat GPT is not without its limitations. It is only as accurate as the data that it has been trained on, and there is always a risk of bias in the data. Additionally, the chatbot feature may not be able to provide answers to all of the questions that farmers may have.

One of the primary disadvantages of Chat GPT is its reliance on large amounts of data to learn and make predictions. This means that if the training data is biased or limited, Chat GPT's predictions may also be biased or limited. Additionally, the use of large amounts of data can lead to concerns about data privacy and security.

Another disadvantage of Chat GPT is the potential for misuse or abuse of the technology. Chat GPT can be used to generate fake news, manipulate public opinion, and impersonate individuals online. As such, there are concerns about the ethical and moral implications of using Chat GPT.

Finally, Chat GPT is still a relatively new technology, and there is much that is still unknown about its capabilities and limitations. As such, there is a need for continued research and development to better understand how Chat GPT can be used effectively and responsibly.

Conclusion

Chat GPT is a powerful AI technology that is revolutionizing the field of agriculture. Its ability to analyze and understand large amounts of data is helping farmers make more informed decisions about their farming practices. From personalized farming plans to real-time crop monitoring, Chat GPT is helping farmers optimize their yields, reduce waste, and improve their overall productivity. And with the continued development of AI technologies, the potential applications of Chat GPT in agriculture are only just beginning to be explored.

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Importance of Dietary Fiber in Human Health

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Pavel Rout[1], Shreya Saha[2]
[1]Dairy Chemistry Division, [2]Dairy Microbiology Division,
Ph.D. Research Scholar, ICAR-National Dairy Research Institute, Karnal Campus, Haryana, 132001.

Abstract

Several studies have shown that consuming whole, unprocessed foods like whole grains, legumes, vegetables, and fruits can help keep your digestive system healthy. Mechanistic studies and clinical trials on isolated and extracted fibers have shown promising regulatory effects on the gut (like digestion and absorption, transit time, and stool formation) and microbial effects (like changes in gut microbiota composition and fermentation metabolites), which have important implications for gastrointestinal disorders. In this article, we have mentioned several fiber-containing foods, their beneficial effects and the mechanism of providing a better gut, reduced heart diseases and certain types of cancers, and the current evidence for using dietary fibers in treating several illnesses. The use of novel fibers and the co-administration of fibers is a therapeutic technique that has yet to be thoroughly studied.

Introduction

Dietary Fiber, also roughage, is a carbohydrate the human body cannot digest. It is found in plant-based foods such as fruits, vegetables, whole grains, legumes, and nuts. Unlike other carbohydrates broken down into simple sugars, fiber passes through the digestive system mostly undigested, providing various health benefits. The importance of Dietary Fiber in human health lies in its ability to improve digestive function and prevent various chronic diseases. Despite its numerous health benefits, many individuals consume diets low in fiber, making it essential to educate people on the importance of incorporating fiber into their diets.

The article aims to provide a comprehensive overview of Dietary Fiber, including its types, sources, recommended daily intake, and health benefits. The article will also discuss the role of fiber in gut health, the challenges of incorporating fiber into the diet and offer recommendations for optimal fiber intake. This comprehensive article is designed to increase public awareness of Dietary Fiber's importance and encourage individuals to make informed food choices. By understanding the health benefits of fiber, individuals can take proactive steps to maintain good health and reduce the risk of chronic diseases (Barber et al. 2020).

Health Benefits of Dietary Fiber

Dietary fiber, also known as roughage, is a carbohydrate not digested by the human body (Mudgil and Barak 2013). Unlike other carbohydrates, fiber passes relatively undigested through the digestive system, providing numerous health benefits. There are two types of fiber: soluble and insoluble.

1. Regulates digestion: Soluble fiber dissolves in water, forming a gel-like substance that slows digestion. This gel-like substance can help regulate digestion and prevent constipation by adding bulk to the stool and promoting regular bowel movements. Soluble fiber can also help regulate blood sugar levels by slowing glucose absorption into the bloodstream. Foods high in soluble fiber include oatmeal, bran, barley, nuts, seeds, beans, lentils, peas, apples, citrus fruits, and strawberries (Muto 1988).

Insoluble fiber, however, does not dissolve in water and helps regulate bowel movements by adding bulk to the stool. Insoluble fiber helps prevent constipation and promotes regularity by preventing the stool from becoming too soft and watery (Khalid et al., 2022). Foods high in insoluble fiber include whole wheat, whole grain bread and cereals, brown rice, bulgur, potatoes, and dark leafy greens.

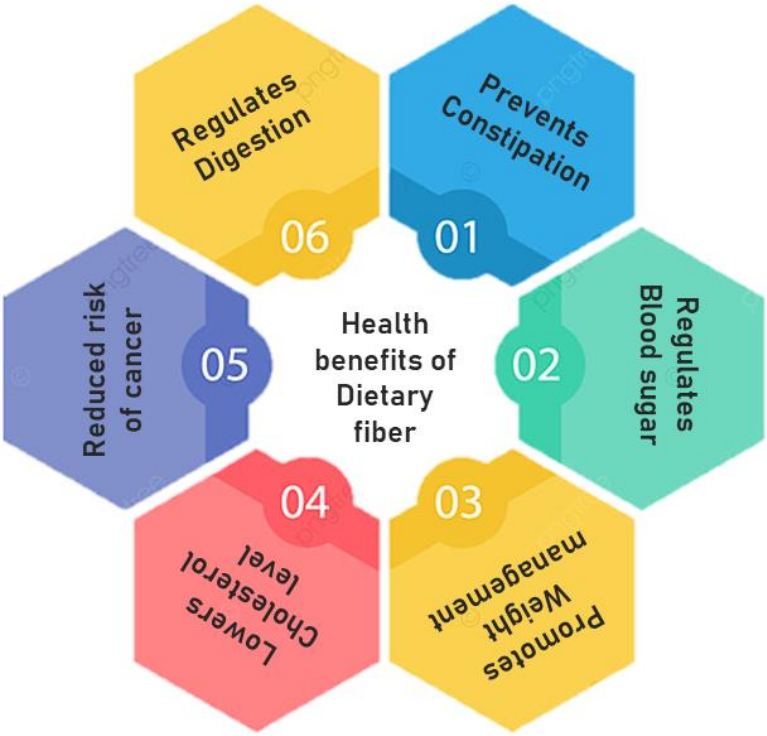

Fig.1. Health Benefits of Dietary Fibre

2. Prevents constipation: Constipation is a common digestive problem that affects millions of people. It is characterized by infrequent or difficult bowel movements and can cause discomfort, bloating, and abdominal pain. A high-fiber diet can help prevent constipation by adding bulk to the stool and promoting regular bowel movements (Turawa et al. 2014). The soluble fiber, in particular, has a laxative effect, which can help relieve constipation by making the stool softer and easier to pass.

3. Lowers cholesterol levels: High cholesterol levels can increase the risk of heart disease and stroke. Soluble fiber has been shown to help lower cholesterol levels by binding with cholesterol in the digestive system and removing it from the body. Studies have found that eating a diet high in soluble fiber can lower total cholesterol levels by as much as 10% (Khalid et al., 2022).

4. Regulates blood sugar levels: Soluble fiber can also help regulate blood sugar levels by slowing glucose absorption into the bloodstream. This is particularly beneficial for individuals with diabetes, as it helps prevent sudden spikes in blood sugar levels. Eating a diet high in soluble fiber can also help prevent type 2 diabetes by improving insulin sensitivity (Weickert and Pfeiffer 2018).

5. Reduced risk of certain types of cancer: Studies have shown that a diet high in fiber may reduce the risk of certain types of cancer, including colorectal cancer (Park et al. 2005). The exact mechanism by which fiber reduces the risk of cancer is not yet fully understood, but it is believed that fiber helps regulate bowel movements, reducing the amount of time that potentially cancer-causing substances are in contact with the colon.

6. Promotes weight management: Fiber has several properties that can help promote weight management. For starters, fiber promotes feelings of fullness and satiety, which can help reduce overall calorie intake. Additionally, fiber slows digestion, which can help regulate blood sugar levels and prevent sudden spikes in hunger (Jakobsdottir et al. 2014,). Finally, fiber are often less calorie-dense than other foods, which can help promote weight loss (Greger 2020).

In conclusion, fiber is a vital component of a healthy diet and has numerous health benefits. Eating a fiber-rich diet can help regulate digestion, prevent constipation, lower cholesterol levels, regulate blood sugar levels, and promote weight management. It is recommended that adults consume 25-38 grams of fiber per day, although most people only consume about 15 grams per day. To increase fiber intake, it is important to make gradual changes and drink plenty of water to prevent digestive discomfort (Buttriss and Stokes 2008).

Recommended Daily Intake of Dietary Fiber

Dietary fiber is an important component of a healthy diet, providing numerous health benefits. However, many people need to consume more fiber to reap these benefits. Understanding the recommended daily intake of fiber is crucial for maintaining optimal health.

The recommended daily fibre intake varies based on age, sex, and level of physical activity. Adults recommended daily intake is 25-38 grams per day. Women should aim for at least 25 grams per day, while men should aim for at least 38 grams daily. The recommended daily intake for children varies based on age and can be found in dietary guidelines (Slavin 2005).

1. Current average intake: Despite the recommended daily intake, most people need to consume more fiber. The average daily fiber intake for adults in the United States is only about 15 grams per day, far less than the recommended amount. This is concerning as a diet lacking in fiber can increase the risk of chronic diseases such as heart disease, diabetes, and certain types of cancer (Howarth et al. 2001).

2. Importance of gradual increase in fiber intake: To increase fiber intake, it is important to make gradual changes to your diet rather than drastic changes immediately. Sudden increases in fiber intake can cause digestive discomforts, such as bloating and gas. Gradual increases in fiber intake and drinking plenty of water can help prevent digestive discomfort and allow the body to adjust to the increased fiber intake (Pinheiro et al. 2017).

Consuming the recommended daily intake of fiber is crucial for maintaining optimal health. The recommended daily intake for adults is 25-38 grams; however, most people only consume about 15 grams daily. To increase fiber intake, it is important to gradually change your diet and drink plenty of water to prevent digestive discomfort (Buttriss and Stokes 2008).

Sources of Dietary Fiber

Dietary fiber is found in various foods, including fruits, vegetables, whole grains, legumes, nuts, and seeds (Soliman 2019). Consuming various fiber-rich foods can help you get the recommended daily fibre intake and the associated health benefits.

1. Fruits and vegetables: Fruits and vegetables are excellent sources of dietary fiber. Fruits such as apples, bananas, oranges, and pears are high in both soluble and insoluble fiber, while vegetables such as carrots, broccoli, and Brussels sprouts are high in insoluble fiber. In addition to fiber, fruits and vegetables also provide important vitamins, minerals, and antioxidants that are essential for good health (Palafox-Carlos et al. 2011).

2. Whole grains: Whole grains are a rich source of dietary fiber, with one serving of whole grain providing about 3 grams of fiber (Korczak and Slavin 2020). Whole grains, such as whole wheat, brown rice, and quinoa, contain soluble and insoluble fiber and important nutrients such as B vitamins, iron, and magnesium. Choosing whole-grain bread, cereals, and pasta instead of refined grains can increase your fiber intake and help promote good health.

3. Legumes: Legumes, such as beans, lentils, and peas, are an excellent source of soluble and insoluble fiber. In addition to fiber, legumes are also a good source of protein, making them a great alternative to meat for individuals following a vegetarian or vegan diet. One serving of legumes can provide up to 10 grams of fiber, making them a great way to increase fiber intake (Flight and Clifton 2006).

4. Nuts and seeds: Nuts and seeds are a good source of soluble and insoluble fiber and important nutrients such as healthy fats, protein, and vitamins. For example, almonds are a good source of insoluble fiber, while flaxseeds are a good source of soluble fiber. Nuts and seeds can be added to meals or used as a snack to increase fiber intake (Albuquerque et al. 2020).

5. Refined grains: Refined grains, such as white bread, pasta, and rice, are often low in fiber and lack many of the nutrients found in whole grains (Barrett et al. 2020). While they may be a convenient source of carbohydrates, they do not provide the health benefits associated with a high-fiber diet. To ensure adequate fiber intake, it is important to choose whole grains instead of refined grains whenever possible.

There are many sources of dietary fiber, including fruits, vegetables, whole grains, legumes, nuts, and seeds. Consuming a variety of fiber-rich foods can help ensure that you get the recommended daily intake of fiber and the associated health benefits. You can increase your fiber intake and improve your overall health by choosing whole grains instead of refined grains and adding more fruits, vegetables, legumes, nuts, and seeds to your diet (Lockyer et al. 2016).

Conclusion

In conclusion, the health benefits of dietary fiber are numerous and far-reaching. From improving digestive health to reducing the risk of chronic diseases, fiber plays a vital role in maintaining overall health and wellness (He et al. 2022). A diet high in fiber can help regulate bowel movements, reduce the risk of colon cancer, lower cholesterol levels, regulate blood sugar levels, improve gut health, and meet nutritional needs. It is important to include a variety of high-fiber foods in the diet, such as fruits, vegetables, whole grains, legumes, nuts, and seeds (Giorgetti et al. 2022). These foods provide a wide range of nutrients and health benefits and can help individuals meet their fiber needs while reducing the risk of chronic diseases. However, despite the numerous health benefits of fiber, many individuals still do not consume enough fiber in their diets. The average fiber intake for adults in the US is only about half of the recommended daily intake (Gustafson and Rose 2022). To ensure adequate fiber intake, it is important to make a conscious effort to include fiber-rich foods in the diet, and to make dietary choices that support overall health and wellness. Incorporating a variety of high-fiber foods into the diet is important in supporting overall health and reducing the risk of chronic diseases. By consuming a diet rich in fiber, individuals can reap the numerous health benefits of this essential nutrient and support their overall well-being.

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Brahmi: The Memory Booster

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Smt. Anisa N. A.[1]

[1]Assistant Professor, Department of Plantation Crops and Spices, College of Agriculture, Vellayani, Thiruvananthapuram, Kerala Agricultural University, 695522.

Brahmi scientifically known as *Bacopa monnieri* (L.) is an important medicinal plant which is known for its memory enhancing capacity. This plant is seen in wet damp and marshy areas throughout tropical and subtropical India. It grows best near flowing water and wetlands in plains and foothills, and is particularly abundant in monsoon. This plant belonging to Scrophulariaceae family is considered to have its centre of origin in wetlands of South India.

Brahmi is one among the 32 prioritized species enlisted by National Medicinal Plants Board. The whole plant is used for medicinal purpose. It comes under the category of Medhya drugs. It has many common names like Thyme-leaved Gratiola, Babies tear, Nirbrahmi, Jalbrahmi, Water hyssop and Herb of Grace. It is sometimes mistaken for *Centella asiatica* which is also an important memory enhancer.

Botany

It is an annual herb with prostrate nature. The plant is small juicy, succulent, glabrous herb which forms root at the nodes with numerous ascending branches. The leaves are fleshy, entire, simple and sessile which are opposite, decussate, obovate-oblong or spatulate. It has pale blue or whitish flowers which are produced in axils. Solitary flowers arranged on long slender pedicels. There are 5 sepals, 0.4–0.9 cm long with corolla tube cylindrical with spreading lips, twice as long as sepals. Capsule is ovoid in shape, acute, two-grooved and two–valved with numerous seeds that are very minute, pale, and irregular. Fruits are ovoid, acute, 2-celled, 2-valved capsules and tipped with style base (Joy *et al.*, 1998).

Chemical Constituents

The major chemical constituents present are Bacoside A & B, Saponins, Monnierin, Hersaponin, Sigmasterol, sigmastanol, D mannitol, β sitosterol, betulic acid (Tamboli *et al.*, 2022). Bacoside on hydrolysis give bacogenins which has haemolytic activity. Hersaponin has neuropharmacological effect. It also contains brahmine and herpestine (Kurian and Shankar, 2007).

Uses

From time immemorial Brahmi is known for its remarkable potential of enhancing memory, intelligence and vitality. The whole plant is used in indigenous system of medicine as a nerve tonic and for the treatment of epilepsy and insanity. It is used as an antispasmodic, astringent, cardio tonic, diuretic, anticonvulsant, anti-inflammatory, analgesic, antipyretic and antiepileptic agent (Ashalatha and Shenoy, 2016). The plant is useful against painful joints, swelling in joints, arthritis, peripheral neuritis, abdominal disorders, constipation and burning urination. It is a stomachic and used in insomnia. It is used in convulsions and mental retardation. It clear voices, improve digestion, and is said to have good potency in controlling cough, fever, chest congestion, laryngitis and asthma. Decoction of the plant is given in the treatment of leprosy.

Varieties

Subodhak, Pragyashakthi and CIM- Jagrithi are the varieties released from Central Institute of Medicinal and Aromatic Plants, Lucknow. Subodhak is a selection from wild collections with a dry herb yield of 4.7 t/ha/harvest with a bacoside A content of 1.6%. Pragyashakti is having pale green stem with greyish leaves and is having a dry herb yield of 6.5 t/ha/harvest with bacoside A content of 1.8%. CIM-Jagriti is having a dry herb yield of 4 t/ha and has high bacoside content of 2%.

Cultivation Aspects

A sub-tropical to tropical climatic condition is suitable for the growth of Brahmi. A temperature range of 33-40^{0}C with a relative humidity of 60-65% is ideal for its growth. The plant grows well in poorly drained soils and is commonly seen grown along the canals and water bodies and in marshy areas throughout India. Clayey loam to clayey soils is best suited for its growth.

Propagation

Soft herbaceous cuttings are used for its mass propagation. The whole plant is cut into small divisions of 5–10 cm length with few leaves and 3-4 internodes, which are the best planting material for cultivation. For planting in one hectare area 62,500 nos. of cuttings are required (Smitha *et al*., 2020).

Planting

The land is cleared well and is prepared to a fine tilth. Shallow beds of 5 cm height are prepared. Shoot cuttings are planted at a spacing of 10-20 cm (Smitha *et al.*, 2020) preferably during May- July. After planting field is immediately flooded. Propagules will take about 1-2 week for establishment and fresh root development. It is better to irrigate the field a day before planting so that the plant can easily establish.

Manures and Fertilizers

10 t of FYM has to be given per hectare as basal dose at the time of land preparation. For medicinal plants it is better to give organic manures like neem cake, groundnut cake, vermicompost etc.

Irrigation

Brahmi is a very small succulent plant. So, it is very essential to water the field after planting for the survival and establishment of the plants. Subsequently, the field should be irrigated at 7-8 days interval. The crop is preferably kept inundated with water, at 4–5 cm depth, throughout the growth period. Irrigation can be avoided during rainy season.

Interculture

Hand weeding is needed at every 15-20 days interval initially. After that the plants will multiply very fast and form a dense mat of vegetation, which will smother the ground, thus prohibiting weed growth. So once the plant gets established, weeding may be done occasionally.

Harvesting

Harvesting can be started by about 4-5 months after planting. After that harvesting can be done once in 2-3 months. Maximum biomass production is seen during October and November. When the plant reaches a height of 20-30 cm, harvesting can be done either by uprooting the whole plant or by cutting above the ground level. It is better to take ratoon crop so that we can take 2-3 harvests. In that case the upper portions of the stem 4-5 cm from the base are removed and the rest is left for further regeneration. After each harvest supply cow dung, compost and ash so that the plant will produce better vegetative growth.

Yield

The plant will give a yield of about 30 t/ha fresh yield and about 6 t/ha dry yield from one harvest. Then from ratoon crop we will get additional yield of about 4-6 t/ha. On an average 3 cuttings can be taken per year. The plant can be maintained for about 2 years, after that yield will decline and we have to replant it.

Post-Harvest Operations

The harvested leaves should be dried by spreading it on clean area or sheets in shade for 5-10 days. The material should be turned over, alternatively during drying for proper drying. The dried material should be stored in clean containers for 6 months. Bacoside content starts reducing after six months of storage. Therefore, long storage should be avoided.

Various products like Brahmighritam, Sarasvataristam, Brahmitailam, Misrakasneham, Brahmirasaayanam, Mahachandanaadithailam, Sudarshanachoornam, Maanasamitravadakam, Mahaathikthaka kashaayam, Memory Plus, Megamind Plus are being made from Brahmi.

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Nanotechnology in Agriculture and Plant Science

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Kamal Kumar Sharma[1], Ruchi Bishnoi[1], Ramesh Kumar[1]
[1]Ph.D. Scholar, Department of Genetics and Plant Breeding, College of Agriculture, Agriculture University, Kota.

Introduction

Nanotechnology has gained intense attention in the recent years due to its wide applications in several areas like medicine, medical drugs, catalysis, energy and materials. Those nanoparticles with small size to large surface area (1–100 nm) have several potential functions. These days, sustainable agriculture is needed. The development of nanochemicals has appeared as promising agents for the plant growth, fertilizers and pesticides. In recent years, the use of nanomaterials has been considered as an alternative solution to control plant pests including insects, fungi and weeds. The field of nanotechnology has great potential within plant sciences and plant production systems. The application of nanotechnology in plant sciences will benefit from the development of improved analytical techniques that enable the *in situ* analysis of NPs *in planta* with a low detection limit and high lateral resolution. Regardless of the benefits of nanotechnology for plant sciences, the principle of 'safety-by-design' must be heeded to address community concerns about the potential adverse effects of novel engineered nanoparticles (ENPs) on ecological systems. However, if we can eliminate the potential risks and outcomes of this innovation, it could potentially reform the entire agricultural cosmos. Several nanotechnological approaches in plant breeding, recom-pensing specific consideration to its current utilization, and moreover, scans the opportunities, potential advantages, associative risks, deterrents, and conceivable prospective changes.

Types of Nanoparticles Used in Plants

Nanoparticles used in this field are of the two types, i.e., metal based, and carbon based. Carbon based nanoparticles are further of two types, carbon nanotubes and fullerenes, while the metalbased nanoparticles are divided into metal oxides, quantum dots and simple metals. The most widely employed metal-based nanoparticles are Titanium dioxide (TiO_2), Silver, Gold, Zinc oxide (ZnO) and Copper. Based on the type of nanoparticles used, they cause many physiological and morphological changes in the plants. The type, chemical composition, reactivity and most significantly the effective dose of nanoparticles are vital in this regard.

Nanoparticles Utilization in Plants

Silicon Dioxide Nanoparticles: It has been noted that a very low concentrations of silicon dioxide nanoparticles improved germination in some plants like tomato, maize etc. Along with the improvement of germination percentages, these nanoparticles also enhanced root length, root diameter and the number of lateral roots in the seedlings.

Zinc Oxide Nanoparticles: Many studies suggest that these nanoparticles increase the rate of development and growth in the plants like soybean, peanut, wheat etc.

Carbon Nanotubes: These nanoparticles have distinct mechanical, thermal, electrical and chemical properties. They can penetrate easily in the cell membrane and cell wall of the plant cell making the process of nanoparticles relatively easier. Increased germination rates by using carbon nanotubes has been observed in *Brassica juncea*, rice, tomato and Bt cotton. It is being observed that carbon nanotubes also contributes to the flowering, fruit yield, biomass and medicinal attributes of some plants.

Gold Nanoparticles: Relatively few studies have been performed to analyses the effects of gold nanoparticles in plants. However, these studies indicate that these nanoparticles significantly improve the seed germination rates in lettuce, cucumber, *Brassica juncea, Boswellia ovalifoliolata* and *Gloriosa superba*.

Silver Nanoparticles: A great research work has been documented on the effects of silver nanoparticles in microbial and animal cells. However, research work on plants is limited in this case. Biologically synthesized silver nanoparticles increase the seed germination and growth of *Boswellia ovaliofoliolata* trees, along with the enhancement of some biochemical attributes and plant growth profile (PGP) of maize, common bean and *Brassica juncea*.

Titanium Dioxide Nanoparticles: These nanoparticles have been observed to increase the seed germination and length of radicle and plumule in canola.

Nano-Genetic Manipulation of Plants

Nanobiotechnology employs nanofibers, nano capsules and nanoparticles for the betterment of plants through gene manipulation. Nano materials are used as vehicles to carry genes and substances into the plant body which trigger gene expression and control genetic material inside the plants. Scientists are of the view that this nanobiotechnology is taking the genetic engineering of plants to a new era of atomic engineering. By utilizing this new approach of atomic engineering, scientists are now able to redesign the DNA of the seeds to incorporate desirable traits like changing yield, growth seasons and colour of the plant into it.

Genetically Modified Plants through Nanobiotechnology

Many companies worldwide are now launching genetically modified crops with better combinations of desired traits. All these efforts are done by scientists to increase the production of the crops to feed the ever-growing population of the world. All the companies previously were employing *Agrobacterium tumefaciens* mediated method for this purpose or in few crops gene gun was also employed. Although now these technologies for DNA delivery in the plant cells have become relatively common and are practiced on a large scale but scientists are of the opinion that besides DNA, the incorporation of other molecules like proteins in the cells is more tedious, difficult and challenging.

Nanobiotechnology and Agricultural Development

Nanobiotechnology has played a prominent role in agricultural development mainly by the better control of plant nutrients, improved disease resistance and pesticides development for sustainable agriculture. Applications of nanobiotechnology in the form of as nano-pesticides and nano-fertilizers is discussed below.

Nano-Pesticides: Besides the wide usage of synthetic pesticides by the farmers, bio-pesticides have their own distinct status in the control of insects and pests. A new technology has been introduced in the field of bio-pesticides, that is the use of nanobiotechnology. In this regard, synthesis of non-toxic and eco-friendly nano-pesticides is of great importance. Metallic nanoparticles exhibiting relatively superior anti-pathogenic, anti-fungal and anti-bacterial qualities are being used in these nano-pesticides. But for the usage of these nano-pesticides in the field, their ecotoxicological aspects on the environment should be considered wisely as these nano pesticides also kill the soil harbouring microorganisms. The soil microbes are mandatory for the plants as they serve many ecological and biological purposes.

Nano-Fertilizers: Nano-fertilizers are made these days which contain silica, iron and titanium dioxide, zinc and gold nano-rods. Nanoparticles of zinc oxide, iron etc. are important as they ensure the efficient uptake of nutrients by the plant. But their success depends upon many factors like plant species, susceptibility and on the size, composition and chemical properties of nano materials including their concentration used. Nano-fertilizers which are eco-friendly and are beneficial too for the ecosystems are more preferred than the conventional ones because the world is moving towards smart agriculture like the organic farming which protects the environment from all the hazards of chemicals.

Nanobiotechnology Application for Mitigating Abiotic Stresses in Plants

Abiotic stress affects adversely plant growth and productivity. Out of all the abiotic stresses, the two-salinity and drought are the most prevalent in all plant. Realizing this fact, scientists and researchers from decades are working to find out new methodologies to overcome these stresses in plants. Employment of nanobiotechnology is another effort of the scientists in this regard. This nanobiotechnology application has gained immense upheaval nowadays because of its promising performance in this field. Plants being sessile living organisms develop in themselves the strength and defense to cope up with the harsh environmental conditions mainly by the modification of their biochemical, molecular and physiological pathways. Nanoparticles are used in this regard to regulate the activities of antioxidant enzymes like chloramphenicol acetyltransferase (CAT), super oxide dismutase (SOD) and peroxidase which are very effective in overcoming the drought conditions. Applications of nano-silicon dioxide particles on plants resulted in the increase of their chlorophyll contents, leaf fresh and dry weights, accumulation of proline and regulation of antioxidant enzymes under saline conditions.

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Correction of Micronutrient Malnutrition

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Gagan B Shetty[1], Dr. S. Channakeshava[2]

[1]III Ph.D, Dept. of Soil Science and Agricultural chemistry, College of Agriculture, GKVK, Bangalore-560065.

[2]Associate Professor, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Karekere, Hassan-573225.

Correction of Micronutrient Malnutrition

The control of vitamin and mineral deficiencies is an essential part of the overall effort to fight hunger and malnutrition. Countries need to adopt and support a comprehensive approach that addresses the causes of malnutrition and the often associated "hidden hunger" which rest intrinsic to in poverty and unsustainable livelihoods. Actions that promote an increase in the supply, access, consumption and utilization of an adequate quantity, quality and variety of foods for all population's groups should be supported. The aim is for all people to be able to obtain from their diet all the energy, macro- and micronutrients they need to enjoy a healthy and productive life.

Strategies for the Control of Micronutrient Malnutrition

1. Increasing the diversity of foods consumed: Increasing dietary diversity means increasing both the quantity and the range of micronutrient-rich foods consumed. In practice, this requires the implementation of programmes that improve the availability and consumption of, and access to, different types of micronutrient-rich foods (such as animal products, fruits and vegetables) in adequate quantities, especially among those who at risk for, or vulnerable to, MNM.

2. Food fortification: Food fortification refers to the addition of micronutrients to processed foods. In many situations, this strategy can lead to relatively rapid improvements in the micronutrient status of a population, and at a very reasonable cost, especially if advantage can be taken of existing technology and local distribution networks. Since the benefits are potentially large, food fortification can be a very cost-effective public health intervention.

3. Supplementation: Supplementation is the term used to describe the provision of relatively large doses of micronutrients, usually in the form of pills, capsules or syrups. It has the advantage of being capable of supplying an optimal amount of a specific nutrient or nutrients, in a highly absorbable form, and is often the fastest way to control deficiency in individuals or population groups that have been identified as being deficient.

4. Public health measures: In addition to the specific interventions outlined above, public health measures of a more general nature are often required to help prevent and correct MNM, because MNM is often associated with poor overall nutritional status and with a high prevalence of infection.

5. Biofortification of staple foods: Biofortification defined as Increasing the bio-available concentrations of micronutrients in edible portions of plants through crop management and genotype improvement.

There are two methods in biofortification:

a. Agronomic biofortification
b. Genetic biofortification.

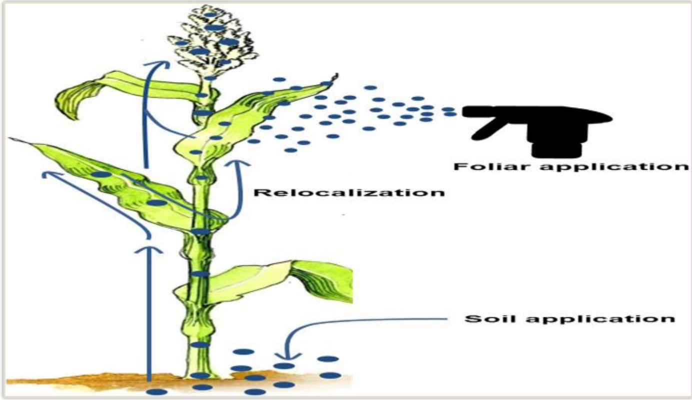
Agronomic Biofortification

Agronomic biofortification is the application of micronutrient-containing mineral fertilizer to the soil and/or plant leaves (foliar), to increase micronutrient contents of the edible part of food crops.

Two methods used:

a. Soil application
b. Foliar application

Agronomic biofortification, especially in the case of foliar application, is highly effective for zinc and selenium, while also effective for iodine and cobalt (Shivay *et al.,* 2015). As an effective strategy for reducing micronutrient deficiency, zinc provides one of the best and quickest avenues for agronomic biofortification, particularly within cereal crops.



Genetic Biofortification

1. Conventional breeding: It refers to crop breeding for varieties with higher micronutrient content. Exploiting the genetic variation in crop plants for micronutrient density is one of the most powerful tools in biofortification of crops, which can reach the poor in rural areas, with low recurrent costs and long-term sustainability. Breeding for specific nutritional qualities require nutrient density traits in high yield cultivars and strategies based on these genetic findings to determine the best selection technique.

2. Genetic engineering: In contrast to plant breeding, the techniques of genetic engineering allow the transfer of heritable traits between completely unrelated species. In recent years, genetic engineering techniques have been used to introduce new traits into commercially important plants thereby producing combinations of features which could not been achieved by traditional breeding (Singh *et al.,* 2013).

Conclusion

Biofortification provides a feasible means of reaching malnourished populations in relatively remote rural areas where markets fail to reach, given that they are largely sustained by subsistence agriculture. Food fortification makes sense as part an integrated food systems approach for reducing malnutrition. It addresses the root causes of micronutrient malnutrition, targets the poorest people, and uses built-in delivery mechanisms that are scientifically feasible and cost-effective, and complement other ongoing methods of dealing with micronutrient deficiencies.

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Role of Plant Regulators in the Fruit Nursery

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Manikanta Swamy A[1], Kondle Ravi[1], Sai Chandana S[1], Neeraj Kumar[1]
[1]Department of Horticulture, Lovely Professional University, Phagwara, Punjab (India) – 144411.

Introduction

The experiment was carried out at Fruit nursery, Lovely professional university, Phagwara, Punjab under an experiential learning program. We have stem cuttings (18-20 cm in length, 10-12 mm in diameter) collected from seven years old plants with at least 3-4 active buds. taken in December and were treated with IBA powder concentrations (0,150, 250, 500, and 750 ppm) by slow dip method for 24hrs. The trial was conducted with 150 cuttings. Then the treated cuttings were planted in the open condition in order to root (raised about 30 cm height) by 10 x 20cm row. Cuttings were irrigated properly immediately after planting. the propagation of Morus strains by cuttings has shown that using IBA@500 ppm is highly effective for the spreads of Mulberry by cuttings. Application of IBA @150 ppm and 500 ppm was found more effective for shoot and root growth of mulberry, respectively, and can be prescribed for use in nurseries for simple and quick mass promotion.

Fig 1: Effect of IBA on rooting of Mulberry cuttings, 1. 0ppm 2. 150ppm 3. 250ppm 4. 500ppm 5. 750ppm

Different compounds known as plant growth agents have the ability to considerably control the growth and development of any plant. Plant hormones or phytohormones and plant growth regulators are the two main classifications of plant growth chemicals (PGR). Plant hormones and plant growth regulators can occasionally be used interchangeably. They are compounding that people artificially create in order to control the growth and development of plants. These chemicals function similarly to the hormones found in plants. The main distinction between plant hormones and PGR is that the former are organic substances produced by plants, whilst the latter are synthetic substances given to plants. There are currently so many PGRs being used often to increase agricultural yields. Regulating the production, metabolism, or translocation of plant hormones may be used to effect this transformation. When the endogenous levels of a plant hormone are insufficient to change plant growth and development, the applied PGR may occasionally raise or drop the endogenous levels of the hormone. As a result, the usage of PGR results in some amazing successes in a variety of fruit crops, with a clear growth, yield, and quality advantage. The precise application of PGRs controls other physiological reactions as well, such as the stimulation of branching, increase or reduce biotic and abiotic stress, delay of pre-harvest drop, enhancement roots, restriction water sprout growth, raise fruit set and colour, delay flower bud formation, thin fruit or flowers, inhibit flower bud formation, improve stress tolerance, and many other things. Since fruit trees are high-value commodities, even a slight improvement in production efficiency, fruit quality, or aesthetic appeal, has the potential to significantly boost output value. The commercial application of PGRs to control fruit growth was a focus of Lawes and Woolley's work in 2001.

Auxin

Most plants use indole-3-acetic acid (IAA) as their primary auxin. It moves from apex to downward polarity. Tryptophan, which is mostly found in leaf buds, new leaves, and even developing seeds, is used to make IAA. IAA is mostly transported from cell to cell; however, phloem may also be involved in transit to the root.

Auxin's ability to promote apical development, cell division, and cell expansion is its most significant function. However, it aids in phloem and xylem differentiation promotes lateral root formation in tissue culture and root initiation on stem cuttings, and mediates the tropistic response of bending in response to gravity and light. Additionally, it can cause parthenocarpy, fruit set, and fruit ripening delays. NAA is a synthetic substance that is used in agriculture to vegetatively propagate plants from stem cuttings. Spraying NAA in various concentrations on different fruit crops is used to control fruit drops in the majority of fruit plants. Usually, it is used following fertilization of the blossoms.

Gibberellin

It was initially taken from the fungus *Giberella fujikuroi*. Mevalonic acid, which is found in the growing seed, young leaves, roots, and immature shoots, is used to make GAs. GAs goes in all directions in the phloem and xylem.

At various phases of growth, gibberellins can control fruit development in a variety of ways. It can encourage stem elongation in long-day plants by encouraging cell division, elongation, and flowering. It also assists in breaking seed dormancy, parthenocarpy, seed germination, fruit setting, thinning of fruit, extending the shelf life of various fruit crops, such as guava, and delaying the senescence of leaves and citrus fruits.

Cytokinin

Zeatin is the most widely distributed cytokinin. Adenine, which is found in root tips and growing seeds, undergoes a metabolic change to create cytokinin. From roots to shoots, cytokinin is transported by the xylem.

In plants, cytokinins play a role in amino acid transport, cell senescence, cell growth, and cell division. In addition to encouraging the synthesis of chlorophyll, seed germination, root initiation, and organ genesis in bananas and papaya, it may increase stomatal opening in some species.

Abscisic Acid

It was once known as abscisin-I, abscisin-II, and dormin, but these names are no longer used. Mevalonic acid, which is found in roots and mature leaves, is converted into ABA, especially in response to water stress. ABA is transported via the phloem and xylem.

Abscisic acid's primary role is to promote stomatal closure when there is a water shortage. It has some impact on the initiation, maintenance, and degradation of abscisin. Fruit crops' viviparous germination and shoot growth may be inhibited.

Ethylene

Ethylene is the sole gaseous plant hormone. Methionine or isoamyl alcohol found in tissues going through senescence or ripening is used to make ethylene. Since it is gas, ethylene travels by diffusion from the point of synthesis.

Often, ethylene is utilized to ripen fruit. It can promote shoot and root growth and differentiation as well as the abscission of leaves and fruits. Several biotic and abiotic stressors, as well as specific stages of plant growth, increase ethylene synthesis and sensitivity.

Conclusion

PGRs are typically sprayed onto leaves or soaked into the ground. Plant growth regulators have a transient impact and must be applied again to have the desired outcome.

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Agronomic Practices for Biotic Stress Management in Field Crops

Article ID: 40646

Athulya S[1], Naveen Kumar A[1], Divya Pooja B[2]
[1]Ph.D. Scholar, Division of Soil Science and Agricultural Chemistry, IARI, New Delhi.
[2]Ph.D. Scholar, Division of Environment Science, IARI, New Delhi.

Introduction

The term "biotic stress" refers to stress that results from harm done to an organism by other living things, such as cultivated or native plants, parasites, beneficial and harmful insects, fungus, bacteria, viruses, and weeds. The types of biotic stresses that an organism is subjected to rely on both the climate in which it lives and the capacity of the species to withstand stress. Pathogens, insect pests, weeds, or intraspecific resource competition are some of the causes of biotic stress factors. The extent to which biotic stress affects yield or quality depends on the environment and thus varies from region to region. In contrast to abiotic stress caused by environmental factors such as drought and heat, biotic stress agents directly deprive their host of its nutrients leading to reduced plant vigor and, in extreme cases, death of the host plant. In agriculture, biotic stress is a major cause of pre and post-harvest losses.

Humanity has suffered greatly as a result of biotic stresses. One such instance is the 'Potato Blight', which was brought on by '*Phytophthora infestans'* and resulted in severe famine in England, Ireland, and Belgium in the 1840s. The 'Grape Phylloxera' that originated in North America caused 'French Wine Blight' in the nineteenth century. Another one of the destructions brought on by plant infections was the Bengal Famine that took place in the 1940s caused by *Helminthosporium oryzae*. Eicchornea crassipes is referred to as the "Terror of Bengal" because of how quickly it spreads across the surface of the water body and grows at an alarming rate. The oxygen demand rises as a result of the light being switched off. Fish and other aquatic species are consequently put to death. Losses to pests and disease in crop plants continue to pose a significant threat to agriculture and food security. During the latter half of the 20th century, agriculture became increasingly reliant on synthetic chemical pesticides to provide control of pests and diseases, especially within the intensive farming systems common in the developed world. However, in the 21st century, this reliance on chemical control is becoming unsustainable. Pesticides tend to have a limited lifespan due to the emergence of resistance in the target pests, and are increasingly recognized in many cases to have negative impacts on biodiversity, and on the health of agricultural workers and even consumers. Due to the implications of climate change, it is suspected that plants will have increased susceptibility to pathogens. Additionally, elevated threat of abiotic stresses (drought and heat) are likely to contribute to plant pathogen susceptibility. These all point out the need of development of sustainable biotic stress management techniques.

Biotic Stresses and their Effects on Crops

Among the biotic stresses caused by various organisms, fungi and viruses are the largest and most important groups affecting all parts of the plant at all stages of growth of food crops. The magnitude of biotic stress effect on the growth and development of plants depends on the ability of the plants to resist a particular stress under a particular environment. Intensive farming practices are no longer sustainable since they are increasingly reliant on synthetic chemical pesticides to manage pests and diseases. Using more and more pesticides causes the target pests to become resistant and has a negative effect on biodiversity. More crucially, because of the effects of climate change, plants will be more vulnerable to pests. Under such situations, gaining better knowledge on physiology of plants could lead to sustainable control of biotic stress.

1. Weeds: Weeds have become the most serious problem, and draws considerable scientific attention. Unchecked weeds cause 20–90% yield losses in different crops. Initial vegetative growth stages are more prone to higher weed infestation due to slow growth habit of the crops with shorter duration. Wider row spacing and initial slow growth results in a larger crop weed competition and weeds also harbour insect-pests by acting as alternate host to the pests, pathogens and nematodes, which cause damage to the crops.

2. Insect-pests and diseases: The losses in yield due to lack of plant-protection measures vary from 46 to 96% depending on the crop and varieties. Delayed onset of monsoon leading to late sowing of crops in dryland areas also increases incidence of pests. Losses caused by major insect-pests and diseases in some of the pulse crops are given in table 1.

Crop	Weeds	Yield loss (%)	Disease	Yield loss (%)	Insect-pests	Yield-loss (%)
Chickpea	*Chenopodium album*, *Melilotus indica*, *Lathyrus tuberosus*	20-35	Fusarium wilt, Asochyta blight, Stunt virus	50-100	Pod borer and Cut worm	10-90
Pigeon pea	*Celosia argentea*, *Portalaca olerace*, *Eclipta alba*, *Euphorbia parviflora*	30-90	Sterility mosaic virus, Fusarium wilt, Phytophthora stem blight, Powdery mildew	20-70	Pod borer and Leaf roller	70-80
Cowpea, Mung bean and Urd bean	*Cyonodon dactylon*, *Cyprus rotundus*, *Amaranthus spp*	50-90	Yellow mosaic virus, Cercospora leaf spot, Powdery mildew, Root rot	10-100	White fly, Jassid and Pod borer	20-55
Lentil	***P**halaris spp*, *Avena spp*, *Chenopodium spp*,	50	Rust, Wilt, Collar rot	20-70	Pod borer	-

Table 1: Losses caused by major insect-pests and diseases in pulse crops

Mechanism of Biotic Stress Management in Plants

The extent and severity of biotic stresses are more pronounced in tropical region than in the temperate region. This is mainly due to the presence of more conducive environment in the tropics throughout the year. In addition, commonly practiced cropping systems by smallholder farmers, especially the multiple cropping system where several crops share the same piece of land at the same growing period provide suitable condition for the long-term presence and infestation of pests and diseases. Biotic stress management is comparatively difficult than abiotic stress management because of the greater difficulty in controlling biotic stresses in an experimental context compared to abiotic stresses. One of the reasons for the difficulty in biotic stress management is, in contrast to vertebrates, plants lack an adaptive immune system, or the ability to adapt to new diseases and memorize past infections. Though lacking an adaptive immune system, plants do have a plethora of strategies to counteract biotic stresses.

Plant mechanisms of resistance to various pathogens and insect pests are known to involve an array of morphological, genetic, bio chemical and molecular processes. The mechanism of defense has been classified as innate and acquired plant response. The overview of plant defense response is represented in Figure 1. An innate defense is exhibited by the plant in two ways, viz., specific (cultivar/pathogen race specific) and non-specific (non-host or general resistance). Specific resistance is either induced in response to only a particular race of pathogen but occurs in all cultivars of the host plant or is activated only in a specific host plant cultivar, but in reaction to all races of a pathogen species.

The molecular basis of non-host resistance is not well studied, but presumably relies on both constitutive barriers and inducible responses that involve a large array of proteins and other organic molecules produced prior to infection or during pathogen attack. Constitutive defences include morphological and structural barriers (cell walls, epidermis layer, trichomes, thorns etc.) chemical compounds (metabolites, phenolics, nitrogen compounds, saponins, terpenoids, steroids and glucosinolates), and proteins and enzymes. These compounds confer tolerance or resistance to biotic stresses by not only protecting the plant from invasion, but also giving the plant strength and rigidity. The inducible defences, like, the production of toxic chemicals, pathogen-degrading enzymes e.g.,chitinases and glucanases, and deliberate cell suicide are conservatively used by plants because of the high energy costs and nutrient requirements associated with their production and maintenance. These compounds may be present in their biologically active forms or stored as inactive precursors that are converted to their active forms by host enzymes in response to pathogen attack or tissue damage.

The systemic acquired resistance (SAR), in which defense proteins accumulate not only at the site of infection but also systemically in uninfected tissues and/or plants. SAR provides long-term defense against a broad-spectrum of pathogens and insects. Another form of induced resistance which, in many aspects is like SAR, is induced systemic resistance (ISR). ISR is potentiated by plant growth promoting rhizobacteria (PGPR) and many of them belonging to Pseudomonas species.

Other than these mechanisms, plant parts such as cuticle, thorns, cell wall *etc.* act as physical barriers to pest and disease infestation.

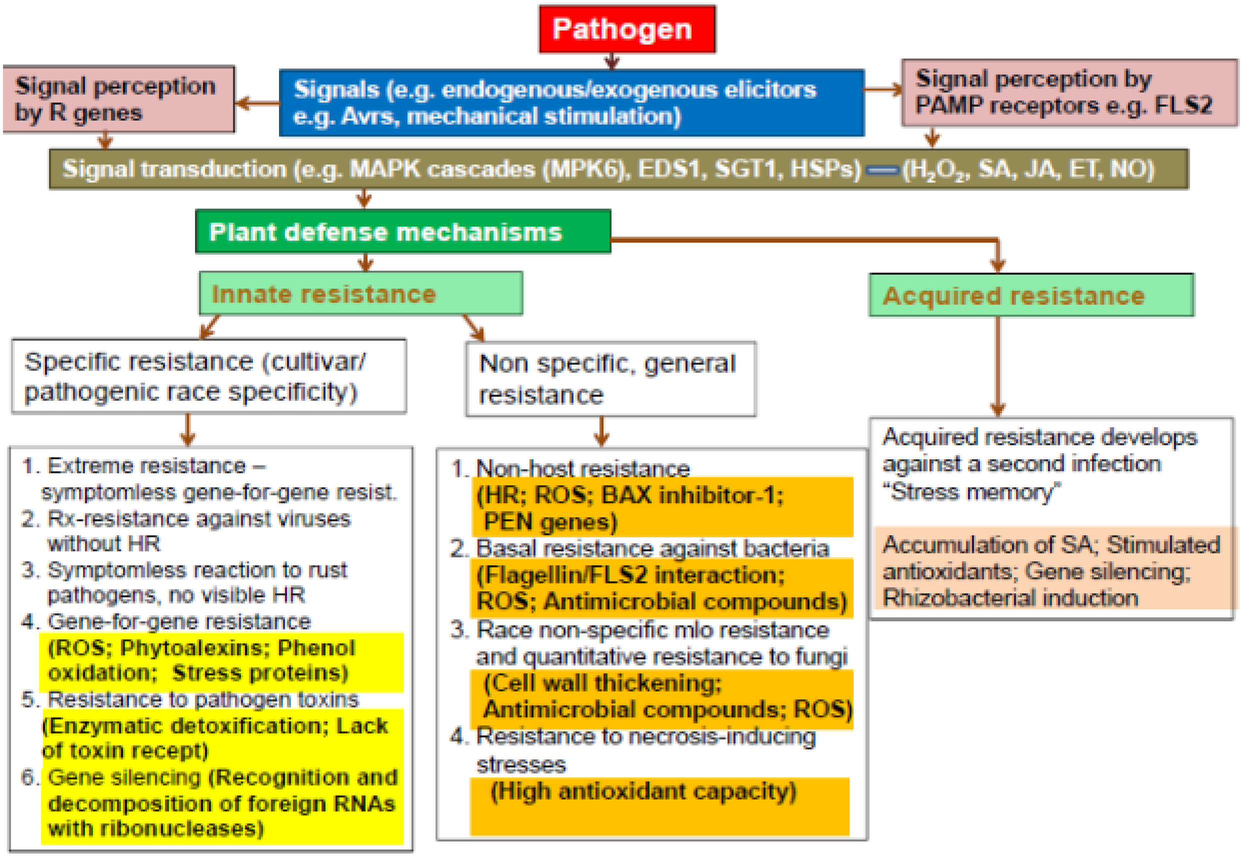

Figure 1: Overview of cellular mechanisms of biotic stress response (Source: Onaga *et al.*, 2016)

Agronomic Practices for Biotic Stress Management in Field Crops

In order to enhance and sustain the crop production, system needs adoption and refinement of low-cost agronomic practices. Many chemicals have though proved effective in controlling biotic stresses, but these are not cost effective. Various non-monetary inputs/ techniques, like selection of crops, selection of drought-resistant/ tolerant/ early-maturing/ short-duration varieties, healthy and disease-free seeds, seed treatment need to be adopted for mitigating abiotic and biotic stress for maximizing productivity and profitability of the farmers. Development and identification of biotic and abiotic stress-resistant varieties is essential to sustain crop production to cope up with the varied climatic scenarios. In general, plant response to abiotic and biotic stresses is crop and cultivar-specific. Development of stress-tolerant varieties is under genetic control, while selection of these varieties is the prime importance of agronomists to produce a satisfactory yield with high productivity potential under stress conditions. Better crop-management practices like tillage, planting time, planting geometry, quality seed, optimum seed rate, method of sowing, mulching, nutrient, weed and water management provide greater opportunities to increase crop productivity in India by mitigating the biotic and abiotic stresses. For dryland pulses, deep ploughing results in better moisture conservation which leads to better root proliferation and higher productivity over shallow cultivation. The conservation tillage system is one such tillage option designed to conserve soil moisture in moisture-deficit areas. This could overcome both abiotic and biotic stresses in pulse crops. Zero-tillage practices can have beneficial impacts on productivity as well as minimizing weed infestation etc.

Soil solarization will help to expose the soil to sunlight which helps in destroying the weed seeds and eggs of pests concealed within the soil. Also, soil addition and seed treatment of plant growth promoting rhizobacteria such as *Pseudomonas fluorescens* also help in controlling pest and disease infestation. Nutrient management also plays an important role in biotic stress management. For example, application of sulphatic fertilizers will reduce the infestation of diseases like powdery mildew as sulphur controls the fungal growth. Planting trap crops around the crop field will protect the main crop from pest infestation (okra/ sunflower in 1:10 ratio in cotton field to trap boll worms). Evidences have shown that crop diseases could be reduced significantly with addition of organic manures/ residues/ amendments. Mayur and Deshmukh (2003) reported that chickpea wilt incidence was significantly reduced by incorporating deoiled mustard cake, groundnut cake and FYM into the soils. It could be ascribed to increased activity of competing micro-organisms in the soil. Apart from these benefits, organic manures have package of micro-nutrients, which could overcome micro-nutrient deficiency in crops besides reducing impact of salinity in the soils.

Integrated pest management (IPM) includes use of resistant or tolerant varieties, crop rotation with non-host crops, etc. in addition to pesticide application at the minimum doses to control pests in crop fields. Integrated pest management encourages natural enemies of pests, use of bio-insecticide NPV (Nuclear Poly Hedrosis Virus) @ 250–500 larval equivalent (LE)/ha, neem-seed kernel extract (5%) and sex pheromone traps are also helpful in controlling pests in crops.

Conclusion

This analysis leads to the conclusion that one of the main obstacles to increasing crop output in India is biotic stress. To address the issue of the nation's nutritional security, it is necessary to reduce the negative impacts of these stresses on crops and increase output. In this endeavor, an integrated approach that incorporates the use of suitable crop/variety adoption, agro-techniques, cultural/mechanical practices, biological agents, and pesticides is required. There is also a need to lay greater emphasis on developing varieties having resistance/ tolerance to various types of stresses using biotechnological tools of crop improvement.

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Recombinant DNA Technology

Article ID: 40647

Venkatesh P[1]

[1]B. Sc (Hons) Agriculture, S. Thangapazham Agricultural College, Vasudevanallur, Tenkasi.

Abstract

Recombinant DNA is the method of joining two or more DNA molecules to create a hybrid.It includes a bunch of techniques that produce unlimited amounts of unavailable or scarce biological product by introducing DNA isolated from animals or plants into bacteria and then harvesting the product from a bacterial colony.

Introduction

The Recombinant DNA technology was developed in 1973 by Boyer and Cohen. Recombinant DNA Technology mainly used to change the phenotype of an organism when a genetically altered vector is introduced and integrated into the genome of the organism. This process involves the introduction of a foreign piece of DNA structure into the genome which contains our gene of interest. The gene which is introduced is recombinant gene and the technique is called the recombinant DNA technology. Recombinant DNA technology is popularly known as genetic engineering.

Keywords: DNA, Host, Insulin, Vector.

Tools

The restriction enzymes used to cut the DNA fragments and the polymerases enzyme help to synthesize the DNA Fragment and the ligases used to bind the DNA fragments. The Endonucleases cut within the DNA strand whereas the Exonucleases remove the nucleotides from the ends of the strands. The restriction endonucleases are sequence-specific which are usually Specific to palindrome sequences and cut the DNA at specific site. A vector is a substance which carries a sequence of DNA or other genetic material and introduces it into a new cell. The four major types of vectors are plasmids, viral vectors, cosmids, and artificial chromosomes. The most commonly used vectors are plasmids. This vector helps to carry desired genes.

Process of Recombinant DNA Technology

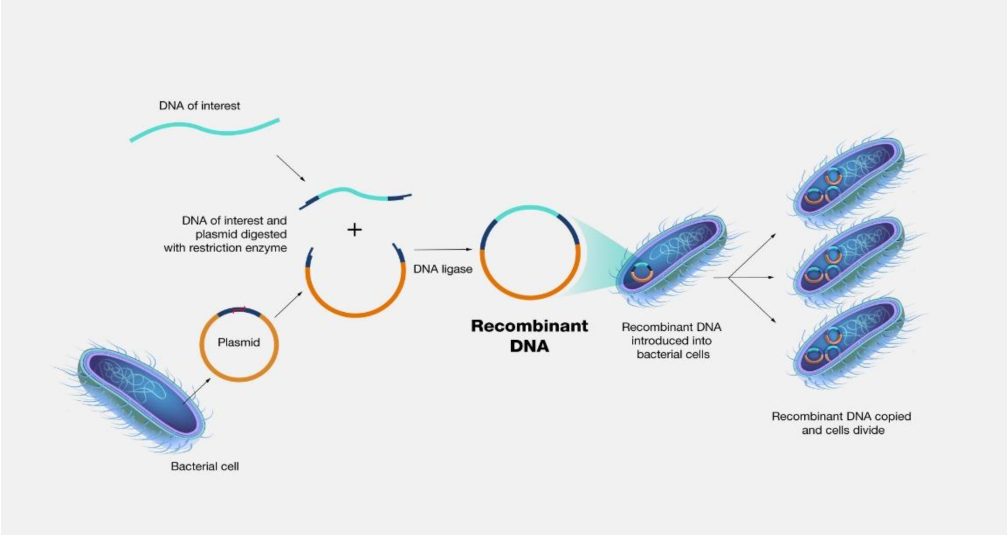
STEP 1: Isolation of DNA: The First step in Recombinant DNA technology is to isolate the desired DNA in its pure form.

STEP 2: Cutting the Gene at Recognition Site: The restriction enzymes play a major role in determining the location at which the desired gene is inserted into the vector genome.

STEP 3: Amplify the Genes by PCR: This process is to amplify a single copy of DNA into thousands to millions of copies once the proper gene of interest has been cut using restriction enzymes.

STEP 4: Ligation: In this step of Ligation, the joining of the two pieces – a cut fragment of DNA and the vector together with the help of the enzyme DNA ligase.

STEP 5: Insert Recombinant DNA into Host Cell: In this step, the recombinant DNA is introduced into a recipient host cell. This process is called as Transformation. Once the recombinant DNA is inserted into the host cell, it will multiplied.



Recombinant DNA Technology

Application of Recombinant DNA Technology

1. Recombinant DNA technology is used to produce recombinant HB vaccines
2. Recombinant DNA is used to produce human insulin.
3. To facilitate better crop production.
4. To produce growth hormones in humans to treat dwarfism.
5. To acquire DNA fingerprinting.
6. To diagnose several types of diseases and gene therapy.
7. Recombinant DNA technology is widely used in Agriculture to produce GMO such as
    a. Flavr Savr tomatoes: Polygalacturonase gene which increase self-life of tomatoes.
    b. Golden rice: Presence of beta – carotene which prevent various eye diseases.
    c. Bt-cotton: It contain Cry 1Ac protein to protect the plant against boll worms.
8. About 60% of U.S. hard cheese is made with genetically engineered chymosin.

Conclusion

Recombinant DNA technology is a fast-growing field and researchers around the globe are developing new approaches, devices, and engineered products for application in different sectors including agriculture, health, and environment. Besides insulin, several new drugs related to recombinant DNA technology have undergone developmental improvements and a number of protein production systems have been developed.

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Fruit Dropping & Cracking of Mango and their Management

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Ram Prawesh Prasad[1]
[1]Assistant Professor - Cum –Scientist (Plant Pathology), Pt. Deendayal Upadhyay College of Horticulture & Forestry, Piprakothi (Dr.RPCAU, Pusa, Samastipur) Motihari East Champaran Bihar-845429.

Introduction

Mango (Mangifera indica) is the leading fruit crop of India and considered to be the king of fruits. Besides delicious taste, excellent flavour and attractive fragrance, it is rich in vitamin A&C. Mango fruit is utilised at all stages of its development both in its immature and mature state. Raw fruits are used for making chutney, pickles and juices. The ripe fruits besides being used for desert are also utilized for preparing several products like squashes, syrups, nectars, jams and jellies. The mango kernel also contains 8-10 percent good quality fat which can be used for soap and also as a substitute for cocoa butter in confectionery. Early and untimely fruit fall from the tree is a serious problem that many mango farmers. Mango blossoms will produce far more fruit than the tree can support, resulting in significant fruit drops.

Fruit cracking occurs because of a physical failure of the cuticle or skin as the result of tensions (stresses) and heavy rains (Ramteke et al., 2017). Because of fruit cracking, water management and nutrition in crops have become a concern for many countries (Fischer & Orduz-Rodríguez, 2012). The lesser pulp thickness and higher stone weight in fruit cracked samples may have responsible for fruit cracking. There was a close relationship between fruit cracking and 3 months average weather conditions. The maximum temperature had positive relation with total fruit cracking.

Fruit Drop

In mango, there is a heavy drop of hermaphrodite flowers and young fruits amounting to about 99% or more. In general, in mango 0.1% or less hermaphrodite flowers develop fruits to maturity Fruit drop, to a certain extent is associated with the variety, as 'Langra' is more prone to fruit drop than 'Dashehari. It appears to be a continuous process and can be classified into three phases, viz. (i) pinhead drop, (ii) post-setting drop and (iii) May-month drop. Fruit drop in the first two phases is insignificant as compared to the third phase which affects the final yield significantly.

Causative Factors

Fruit drop is a complex phenomenon influenced by cultivar, cultural practices and environmental factors. Self-incompatibility; inadequate pollination; unsuccessful fertilization; embryo degeneration; defective perfect flowers; low stigmatic receptivity; poor pollen transfer; high/low temperature and strong winds; nutritional and hormonal imbalances; insect pests (mango hopper and mealy bug) diseases (powdery mildew and anthracnose) and moisture stress and competition among developing fruits are mainly responsible for fruit drop in mango.

Integrated Management Practices

1. Fruit drop can be effectively minimized by spraying 2, 4-D at 20 ppm at pea stage. A single spray of NAA at 20 ppm or Alar at 100 ppm also reduced fruit drop. At IARI, CPPU when applied at 0.1% in the first week of May retarded fruit drop in cv. Langra. Application of spermine (0.01mM) at the pea stage followed by another spray 20 days thereafter, led to a substantial improvement in fruit retention in cv. Kesar at Navsari. Urea and KNO3 sprays ranging in concentration from 1 to 4 % applied at full bloom have been shown to increase fruit retention.

2. Foliar sprays of 0.2 to 0.8 % ZnSO4 and boric acid applied at late bud swell stage have also resulted in increased fruit retention. Apart from these, regular and frequent irrigation during the fruit development period, planting of wind breaks around the orchard and timely plant protection measures can also reduce fruit drop in mango.

3. A spray of Alar (B-Nine) @ 100 ppm. or 20 ppm. 2,4-D (2g. in 100 l. water) in the last week of April or in the last week of May will control to some extent the summer fruit drop in Langra & Dashehari.

Fruit Cracking

In the past few years, incidences of fruit cracking have been observed and reported from different parts of the country. It is observed in mature fruits rendering them unmarketable. Fruit cracking appears to be a varietal character.

Symptoms: In this disorder, fruits crack while still on the tree. Clean and knife-like incisions appear on the fruit which run deep. The cracks become brown and dried out. At times, sap may ooze from such cracks. Secondary infections by fungal pathogens (*Colletotrichum gloeosporioides*) may follow cracking.

Causative Factors: Fruit cracking is primarily associated with moisture imbalances and micronutrient deficiencies. It usually occurs when trees are heavily irrigated after a prolonged dry spell or if heavy rains are intermixed with dry spells. Another cause of fruit cracking is infection by bacterial black spot disease (*Xanthomonas campestris*) and boron difference.

Integrated Management Practices

1. The management strategy for fruit cracking involves regular watering during the fruit maturation stage, mulching to conserve soil moisture, addition of organic manures in the soil to replenish its fertility and application of micronutrients.
2. Foliar sprays of boron were found effective in reducing fruit cracking. Prevention of internal necrosis and bacterial black spot can also reduce the incidence of fruit cracking in mango.
3. Trees should also be protected against strong and desiccating dry winds.

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Integrated Fish Farming with Agriculture: A Significant Tool for Double Income and Food Security

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Priya Dey[1], Sanjoy Samanta[2]
[1]MSc. Scholar, Fisheries Science, Seacom Skills University, Bolpur, Birbhum, West Bengal, India.
[2]PhD Scholar, Agricultural Entomology, UBKV, CoochBehar, West Bengal, India.

Abstract
In India, fishing is a vital economic activity and a thriving industry with a wide range of resources and possibilities. When it comes to overall fish production, the nation comes in second place globally. The nation produces roughly 9.06 million metric tonnes of fish annually. In India, aquaculture has advanced from a historic backyard hobby to a sustainable commercial farming operation. Aquaculture has seen significant species and system diversification during the past three decades, with an astounding yearly growth rate of (6-7%). More than 95% of all aquaculture productivity and over 60% of all fish production comes from freshwater aquaculture. The fact that fish is a significant source of protein further highlights the importance of aquaculture. Systems for producing, managing, and using livestock, agricultural, and aquaculture all together, with an emphasis on aquaculture, are referred to as integrated fish farming systems. Integrated fish farming has a long and illustrious history throughout Asia. Records of fish and grass culture rotation date back to the fourteenth to seventeenth centuries. The mulberry-dike fishpond, the integration of fish and cattle farming, and complex systems of numerous industries linked with fish farming had all been constructed. Fish are raised using integrated farming techniques, which also include the cultivation of paddy, pigs, and chickens, other livestock, and flowers.

Keywords: Integrated Fish Farming, Sustainable Fish Production, Double income, Food Security, Agroecosystem, Agriculture.

Introduction
India has 2.36 million hectares of ponds and tanks available for aquaculture. In contrast, 0.72 million hectares of upland lakes and 3.15 million hectares of reservoirs might be used for aquaculture in addition to 0.12 million kilometers of canals (Ahmed and Garnett, 2011). In India, ponds and tanks are the main sources of freshwater aquaculture. Yet, India currently uses less than 10% of its natural potential for aquaculture. In the eastern half of the country, particularly in the states of West Bengal, Odisha, and Andhra Pradesh, freshwater aquaculture activity is significant. New areas are now coming under it in the states of Punjab, Haryana, Assam, and Tripura (Debnath *et al.,* 2013).

Under the Integrated fish farming (IFF) paradigm, fish farming is practiced along with one or more activities from poultry, dairy, horticulture, duck rearing, and poultry. Fishing and all of these other hobbies are complementary to one another. For instance, the creation of plankton (natural fish food) in the pond uses cow dung as manure (Chen *et al.,* 1995). In addition, dairy is a consistent source of income for farmers. For organic fertilizer, duck droppings work well in fish farming. For every 40 to 50 kg of this organic manure, 1 kg of fish meat can be produced. Also, fish are given access to oxygen when swimming in the pond when ducks are flapping their wings. Pond mud can be used as fertilizer for land crops, which can then be utilized as feed for livestock, poultry, or fish, resulting in the creation of a recycling ecosystem (Haobijam and Ghosh, 2023). The cultivation of fruit-bearing trees like bananas, papaya, drumstick, and other horticulture output can also be done on the dikes of ponds (Mathias and Anthony, 2020).

Basic Principles of Integrated Fish Farming
The foundation of integrated fish farming is the idea that "there is no waste," and that "trash" is merely a misplaced resource that may be turned into a valuable component for another product (Little and Edwards, 2003). The fundamentals of integrated farming are conservation, including complete utilization of farm wastes, and utilizing the synergistic impacts of connected farm activities.

It is considered that this combination would be advantageous for all of the system's components. Yet, fish are typically the biggest winners since they either directly or indirectly use agricultural and animal waste as food (Ayinla, 2004). Due to the fact that integrated farming recycles trash, it has been seen as an economical and effective method of environmental management.

Types of Integrated Fish Farming

Paddy-Cum-Fish Culture: There is always a tiny population of fish that may reach waterways that are present in rice fields that are submerged for 3 to 8 months out of the year. The deliberate stocking and harvesting of fish were likely a result of this. It has long been a tradition in India to use "gamcha or dhoti" to catch fish and prawns in fallow paddy fields. Fish culture in paddy fields has been a farmer's off-season occupation.

The Advantages of Paddy-Field Aqua-Culture are as Follows

1. Aquaculture on paddy fields gives farmers a boost in income.
2. Paddy-field aquaculture provides a vital feed for the inhabitants in regions where fish and rice are the main foods.
3. Since paddy and fish can be cultivated concurrently or alternately in the same water mass, it takes very little additional input in the form of additional costs, especially in management and labor.
4. It gives farmers and farm labourer's employment during the off-season.
5. Fish farming and paddy farming work well together. By exerting good control over undesired weeds, molluscs, harmful insects, and their larval stages, fish farming encourages better paddy production.

Paddy-Field Aquaculture Types

There are three main forms of paddy-field aquaculture that are typically used:
1. Synchronous, concurrent, or simultaneous farming.
2. Rotating paddy fields with fish (either alternately or sequentially.
3. Relay farming.

Duck-Cum-Fish Farming

Although duck and fish farming has long been practiced in eastern Europe and China, and their compatibility has long been acknowledged, the interaction and advantages of the relationship were only recently realized. In the past ten years, practical techniques for growing ducks in fish ponds have been developed in a number of nations.

Clearly, a combination culture like this one is quite beneficial because it significantly boosts the number of fish and duck protein produced per square foot. The combination of duck and fish farming is currently seen as a technique to lower the cost of feed for ducks, while on the other hand, the excreta of ducks' act in an affordable way to fertilize ponds, resulting in the production of both fish and ducks.

Hence, ducks can be regarded to be 'living manuring machines'. The duck excretions include a variety of components like carbon, nitrogen, phosphorus, potassium, calcium, etc. along with 25% organic and 20% inorganic chemicals.

Moreover, ducks aid in the release of nutrients by stirring up the pond's shorelines. In addition, ducks consume a wide range of organisms, including weeds, snails, unwanted harmful insects and their larvae (some of which are vectors of fish pathogenic organisms), tadpoles, frogs, and water-borne disease-causing organisms that infect humans, the eradication of which is one of the key components of farm management.

Advantages:

a. As the ducks' waste fertilizes the pond water, there is essentially less additional cost for fish cultivation.
b. Ducks aid in the release of nutrients by stirring up the pond shorelines.
c. The price of duck feed is decreased.
d. Because they eat a range of species including weeds, snails, undesired harmful insects and their larvae, tadpoles, frogs, etc., the ducks assist in the eradication of vectors of fish pathogenic organisms and waterborne diseases — causing organisms infecting humans.

Disadvantages:

a. The fingerlings that are released must be larger than 10 cm, or else the ducks may eat them.
b. Ducks occasionally cause damage to the earthen dykes while scavenging for food. With proper care, this issue can be resolved.

Fish-Cum-Poultry Farming

Poultry dung is a particularly effective fertilizer for fish ponds, hence integrated fish farming with poultry is typically practiced. The poop from the chickens contains 2% nitrogen, 1.25 percent phosphoric acid, and 0.7 percent potash. Poultry farming is a frequent investment for poor farmers, along with fish farming, due to the inexpensive cost of feeding each individual bird.

Advantages:

a. Because chicken dung is such an effective fertilizer, the pond water doesn't need to be fertilized with chemicals. Fish raising becomes less expensive as a result.
b. More fish food is not necessary.
c. Each bird just costs a small amount to buy and feed.
d. Chicks are easily accessible, and with straightforward and affordable management, their productivity can be increased.

Disadvantages:

a. Occasionally inspect the chicks and isolate any that are sick to prevent the loss of the entire flock.
b. There should be enough time between each stocking of chicks for the house to be renovated and cleaned.

Fish-Cum-Pig Culture

When pigs and fish are raised together, the "pig dung" from the pigs is used to condition the land and supply the nutrients needed to fertilize the pond water. In China, where pigs are viewed as "cheap fertilizer factories," fish-cum-pig culture is widely practiced.

Almost 70% of pig manure is digestible fish food. Enzymes that continue to work even after defecation are mixed with the feed as it travels through the pig's alimentary canal. These undigested materials are a direct source of food for common carp and tilapia. Weeds are a significant issue in tropical fish ponds for fish culture. Such a plant is regarded as a valuable source of pig feeding.

Thus, pigs aptly play a role in biological control of weeds.

Advantages:

a. By increasing production per unit of land, integrated farming boosts farmer income by a factor of two or more.
b. Pig poo supplies ready-made organic matter that contains the necessary nutrients and improves the soil of a new pond.
c. About 70% of the digestible matter in pig dung can be used as fish food. Tilapia and common carp receive their direct diet from the undigested solids found in pig dung.
d. Since that weeds are a valuable source of food for pigs, pigs play an appropriate part in the biological control of weeds.

Disadvantages:

a. An excessive amount of pig dung may increase the nitrogen load in the water body, causing pollution and fish mortality.
b. Pollution prevention calls for a great deal of care and managerial expertise. It has been discovered that substantially less manuring is necessary to get a desirable level of fish output.

Another Integrated Fish Farming Programs

1. Fish-Cum-Cattle Farming: Pipes carry livestock excrement and washings from the cattle sheds into the ponds, which serves as beneficial fertiliser. Often, cattle faeces are gathered in a pit for later use. In addition to increasing fish yield, beef and milk production benefit the economy.

2. Cultivation of fish-cum-rabbits: It has been discovered that rabbit farming is the perfect complement to small-scale fish production. As a direct food source for fish, rabbit excrement is more valuable than other livestock wastes.

3. Fish, mulberry, and cumquat farming: In order to produce silkworms, mulberry plants are planted on the fish farm's dikes and in the nearby fields. Fish are fed on the debris from mulberry trees as well as silkworm larvae and pupae (after the silk has been removed). Moreover, it fertilises the pond's water.

Benefits of Integrated Fish Farming

Integrated fish farming has the following benefits:
1. Complete use of farm wastes.
2. Making use of the synergistic impacts of associated agricultural activities.
3. It expands work options.
4. It improves the farmer's family's access to food.
5. It increases farm productivity, keeps it constant, and reduces risk (both physiologically and economically.
6. It raises the rural population's income.
7. In some regions, it is a method of land reclamation.
8. It is a cost-effective and effective method of environmental management.

Disadvantages: Integrated fish farming has some drawbacks, including recent debate among academics over its effects on public health. It is widely believed that integrated fish farming with pig and poultry production may be the root of the current influenza pandemic. It's possible that by using pigs as "mixing vessels" for human and avian influenza viruses, new fatal viral strains can evolve.

Fish themselves have no part in such a thing. Unfortunately, there is no concrete proof that integrated farming poses a risk to the public's health. Pig-poultry pairings in integrated fish production should therefore be avoided for safety reasons.

Conclusion

By the provision of secure food, integrated fish farming is a real means of reducing or eliminating poverty. Its technology has all been fully created and is available for use by those who are interested. Women and young people, two vulnerable groups in our society, are underrepresented in this lucrative agricultural production subsector. The liberation of women and young people from the constraints of enormous fish imports, which is a significant drain on foreign cash, is crucial. An integrated fish farming system has the ability to close the significant gap between fish demand and supply by concentrating on diverse agricultural production with an emphasis on fish. The fish-integrated culture is examined, highlighting its significance and relevance to reducing poverty and ending hunger. The potential for greater fish production through aquaculture has not yet been fully realised.

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PPFM for Mitigating Drought Stress

Article ID: 40650

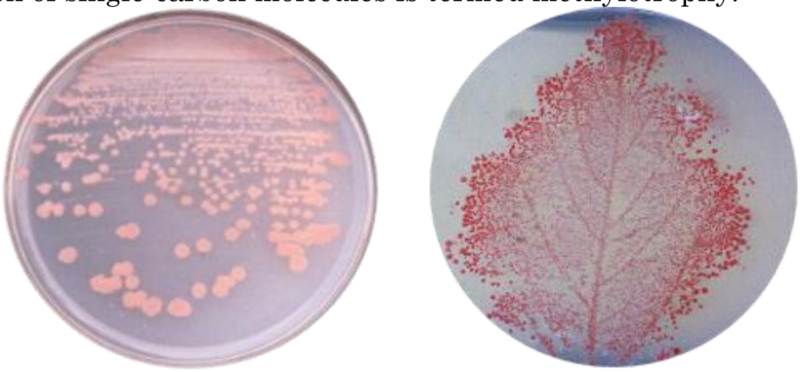
Abishagu A[1], Aakash R[1], Ahazkar A[1], Ajkar Ali A[1], Jaya Lakshmi T[1], Kiruba K[1], Sujitha P[1], Mini ML[2]
[1]M.Sc Scholar, [2]Associate Professor,
Agricultural College and Research Institute, Madurai, Tamil Nadu, India.

Introduction

Drought is one of the major abiotic stresses which adversely affect crop growth and yield. Drought-induced changes are mainly related to metabolic functions, such as reduced synthesis of photosynthetic pigments, accumulation of osmoprotectants like proline in the cell, and decline in the cell membrane stability. In order to overcome the drought, the antitranspirants are applied as foliar spray. Microorganisms that have symbiotic relationships with plants exhibit various strategies for mitigating drought-induced damage in plants. Among different groups of the plant microbiome, methylotrophic bacteria play a vital role in enhancing plant growth under drought conditions. Methylotrophs are significant plant colonizers. They rapidly colonize plant tissue since they use methanol, the by-product of plant metabolism as their food

PPFM

Bacteria belonging to the genus Methylobacterium are commonly known as Pink Pigmented Facultative methylotrophic bacteria (PPFMs). Their pigmentation is mostly pink but may also be yellow or orange due to the presence of carotenoids. The Methylobacterium strain was first isolated from earthworms and named Bacillus extorquens by Bassalik in 1913. They are able to utilize C1 compounds, especially methanol, and oxidize them with the help of their enzymes. PPFMs are thus identified as scavengers of methanol produced by plants. The utilization of single-carbon molecules is termed methylotrophy.



Pink colonies and leaf print of PPFM bacteria

PPFM used to improve plant growth such as fastening seed germination and seedling growth, accelerate vegetative growth by producing phytohormones, increase leaf area index, chlorophyll content, fruit set and improve fruit quality. Application of PPFM can increase yield by 10% by increasing nitrogen fixation, phosphate solubilization, plant growth regulators and urease enzyme production.

Drought Tolerance Mechanism

Under drought conditions, plants produce higher amounts of ethylene, reactive oxygen species and also increase the frequency of stomata closure and membrane damages, which results in yield loss. Ethylene causes an adverse effect on photosynthesis; stomatal conductance and it interacts with the plant hormones such as auxin and abscisic acid. Plants treated with PPFM synthesize ACC deaminase, an enzyme that interferes with ethylene production, thereby reducing the impact of drought stress. PPFM can also induce the production of antioxidant enzymes and osmolytes in plants and thus helps in mitigating drought stress. PPFM can regulate stomatal closure and experiments have shown that plants treated with PPFM had higher relative water content in their tissues compared to untreated drought-stressed plants.

Method of Applying PPFM

PPFM is recommended for all crops at critical stages of growth or at 30 days intervals. It can be applied to seeds or as a foliar spray. When applied as a foliar spray, it should be sprayed during the morning or evening and should not be mixed with pesticides or fungicides.

1. Seed treatment: Soak seeds in 1.0 % volume of PPFM for 5-10minutes depending on the seed

2. Foliar spray: Apply 1% PPFM as foliar spray

Conclusion

PPFM is an ideal choice for mitigating drought stress in agricultural crops as it is an eco-friendly and pollution-free strategy. Application of PPFM will be beneficial to farmers in boosting their crop yield and hence their economy in spite of environmental adverse effects.

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Feed Formulation and Preparation in Aquaculture

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Rajesh V. Chudasama[1]
[1]College of Fisheries Science, Kamdhenu University, Navsari-396450.

Feed is one of the major inputs in aquaculture production. Consequently, there is a growing demand for good quality feeds, which can give a good feed conversion ratio. In this article, the author described how the feed formulation of some basic inputs and feed preparation step-by-step information with photographs. It is feed preparation for small-scale fish farming large scale manufacturing of the feed procedure are same but manpower and machinery require.

Artificial Feed Formulation

1. Feed formulation is the process in which the appropriate feed ingredients are selected and blended to produce a diet with the required quantities of essential nutrients.
2. No single ingredient can be expected to meet all nutrient requirements of cultured organisms.
3. By selecting various ingredients in the correct amounts, a compounded ration, which is nutritionally balanced, can be prepared.

Pre-Requisite Information for Feed Formulation

1. Nutrient requirements of the species to cultivate
2. Feeding habits of the species
3. Locally available feed ingredients, cost, and nutrient composition
4. Digestibility of ingredients
5. Type of feed processing desired.

Diet Formulation

The step-in diet formulation is balancing the crude protein and energy levels. This can be accomplished by trial and error, by the Pearson square method for either crude protein level or energy level and then adjusting, or by solving simultaneous equations. At first, it is helpful to use at least three feed tuffs during the initial balancing of protein and energy levels: one high in protein and high in ME, one low or intermediate in protein and high in ME, and one low or intermediate in both protein and ME. Once practice makes one more proficient at diet formulation any number of feedstuffs can be used. One must remember to reserve a room in the formulation for any feed additive, such as a vitamin or mineral pre-mix.
1. Diets are formulated to fulfill the nutrient requirement.
2. If the protein and energy content of the diet is satisfied, then other nutrients are automatically augmented.
3. However, marginal supplementation of the nutrient is required, if necessary: Lysine, methionine, and essential fatty acids.
4. Some feed additives like binders, attractants, colouring agents, antioxidants or medicine (antibiotics and other growth stimulants, etc.), and carotenoids.
5. Pearson's Square Method: To balance the protein.
6. Trial and Error method: Final balancing of protein and energy by reorientation of formula.

Process Flow Chart of Sinking Feed Preparation

Selection of feed ingredients and feed formulation
↓
Grinding of ingredients
↓
Dough Preparation and cooking
↓

Cooling
↓
Mixing of vitamin- mineral premix and additives
↓
Pelleting
↓
Pellet Drying
↓
Storage

Table 1. Artificial feed proximate composition for 35% crude protein level:

Ingredient	Crude Protein (%)	Inclusion Level (%)	CP (%)	Quantity of Ingredients (g)	Ingredient Price (Rs.)/kg	Price (Rs.)
Fish meal	55.00	13.70	7.54	137	55	7.54
GNOC	48.00	54.00	25.92	540	45	24.30
Wheat flour	10.00	9.30	0.93	93	20	1.86
Tapioca flour	0.50	12.00	0.06	120	35	4.20
Rice bran	7.00	10.00	0.70	100	10	1.00
Mineral mix	0.00	0.50	0.00	5	60	0.30
Vitamin mix	0.00	0.50	0.00	5	60	0.30
Total		**100.00**	**35.15**	**1000**		**39.50**

Fig. 1. Ingredients for feed preparation

Fig. 2. Mixing of feed ingredients

Fig. 3. Dough preparation

Fig. 4. Cooking of dough

Fig. 5. Cooling of dough

Fig. 6. Mixing of minerals, vitamins, and additives

Fig. 7. Pellet Drying

Fig. 8. Feed Packing

Fig. 9. Feed Packets

Conclusion

In feed formulation fish meal, groundnut oil cake, wheat flour, tapioca flour, rice bran, and vitamin minerals premix powder ingredients are used. The prepared feed was sinking feed because of the no use of the extruder. Prepared feed in crud protein level is 35% which is a highly recommended level for most of the farmed fish cultivation. That feed is stored in an airtight container for longer storage.

Food Gels and its Importance

Article ID: 40653

Ankita Choudhary[1], Monika Sood[1], Julie D Bandral[1]
[1]Sher-e-Kashmir University of Agricultural Sciences and Technology-Jammu(J&K).

Food Gels

Gels is a soft, solid, semi-solid material that retains large amount of water in their system or in simple words can be defined as solidified liquids. Gels can be classified on the basis of their bonds into two main types: physical and chemical gels which can be distinguished by the nature of bonds i.e physical gels are linked non covalently whereas chemical gels linked by covalent bonds. Gels have gained importance in food as it provides convenience to consumers in the form of products like jam, jelly, deserts, quick setting products etc. Gels are relished due to their low-calorie content, taste, nutritional and fullness attributes.

Food gels are viscoelastic or soft flexible polymeric materials which has the capacity to retain water (hydrogels), air (aerogels) or oil (oilogels) in their three-dimensional structure. Hydrogels exhibit various applications in food packaging, nutrient enrichment, satiety and freshness detection. Hydrogels can be used as films, coatings, nanoparticles, and emulsions as per need. Usually, hydrogels with single network are too brittle therefore more than components are added to improve the strength. The gels are formed by interactions between the polymers, polysaccharides and proteins.

Formation of Gels

Based on the mechanism of synthesis, food hydrogels can be classified into physical cross linking, chemical crosslinking and biological cross linking (Liu *et al*., 2022)

Physical crosslinking- Physical crosslinking refers to the formation of food hydrogels by covalent bonds by intermolecular or intra-molecular forces, such as hydrogen bonding, ionic interaction, electrostatic complexation, or intermolecular entanglement. The network structure of food-based polymer is fragile so the transition from solution form to gel is easily achieved.

Chemical crosslinking- The gels are covalently crosslinked with intermolecular disulphide bonds or food grade crosslinking agents. The chemically crosslinked gels do not require to remove the reactant after gelation and are more stable.

Biological crosslinking- It refers to crosslinking of natural substances catalysed by enzymes such as transglutaminase, lactase, horseradish peroxidase etc.

Gelling Agents

1. Gelling agents are the food additives that are added to improve the texture of the food.
2. Most commonly used gelling agents are pectin, starch, natural gums and agar-agar.
3. They are used to thicken and stabilize various foods.

Types of Gels (Banerjee *et al*., 2012)

Hydrogels:

a. Colloidal gel in which water is dispersion medium
b. Hydrogels materials like agarose, methyl cellulose, and naturally derived polymers

Organogels:

a. Thermoreversible solid, liquid can be organic solvent, mineral oil or vegetable oil
b. For example, wax crystallization in crude oil

Xerogels:

a. Solid formed by shrinkage from gel
b. Retains high porosity and high surface area

Aerogels:

a. Colloidal gel in which gas is the dispersion medium

b. Low density and excellent thermal properties

Weak gels:

a. Also known as elastic gels
b. Polysaccharides such as xanthum gum and gellan gum.

Fluid gels:

a. Occurs when hot hydrocolloids are cooled allowed to set
b. A light pourable gel or thicker paste.

Temperature sensitive gels:

a. Thermoreversible gel which melt on heating and gel upon cooling e.g Gelatin
b. Thermo-irreversible gels which once formed on heating will not melt e.g alginate.

Multi composite/components gels:

a. Combination of biopolymers with inclusion of different solutes
b. Whey protein and polysaccharide are two biopolymers used in gelling.

Binary gel: Two components modify the gel characteristics without any interaction. Eg. addition of dextran to gelatine

Filled gels: Gel with particulate inclusions where fillers can be gas bubbles, liquid droplets fat or cellular components. Eg. Starch gel

Polysaccharides with surfactant micelles: an anionic surfactant such as SDS when added above critical limits viscoelastic gels are formed.

Polymers with heat setting proteins: a globular protein with ph higher than isoelectric point forms gel on heating.

Starch reinforced protein gels: Starch imbibes water during gelatinization concentration of protein increases and when it gels at high temperature, a strong protein matrix is formed.

Emulsion gels: Emulsion gels can be prepared by creating emulsion with edible oil followed by heating with protein to attain well set gel.

Instant gel: Multicomponent gel can be prepared by selecting appropriate factors such as temperature, ph, catalyzing agents etc. in less time.

Application of Food Gels

1. Smart packaging:

a. Encapsulation provides protection and increases shelf life
b. Safe green and multifunctional packaging.

2. Chitosan based packaging:

a. Antibacterial and antioxidant activity
b. Moisture resistant activity and good mechanical properties

3. Cellulase based packaging:

a. Non-toxic and biodegradable
b. Versatile polysaccharides and renewable biopolymer.

4. Sodium-alginate based packaging:

a. An anionic polysaccharide
b. Biodegradable and hydrophilic.

5. Provide satiety:

a. Protein prolongs satiety
b. Fruit and vegetable provides dietary fiber.

6. Nutrient delivery:

a. Nutrient rich functional foods
b. Nutrient preservation depends on packaging and processing tools.

7. Encapsulation of bioactive ingredients:

a. Good encapsulation ensures chemical stability and efficacy of bioactive agents.

b. Efficient nutrient delivery.

8. Freshness testing:

a. Avoid food wastage and spoilage by freshness testing and monitoring technologies.
b. Natural dyes such as anthocyanins are safer and more effective than synthetic dyes.

9. Absorption of food colouring:

a. Hydrogels have unique adsorption mechanical properties
b. High porosity, high surface area and reusable properties.

10. Food safety monitoring:

a. Hydrogel activity monitors multifunctional developments (antimicrobial, regenerative, degradable, and adsorption.)
b. Food quality indicators prevent consumption of unsafe food.

Confectionary Food Gels

Confectionary food gels are high sugar systems. It can be prepared by sucrose, glucose syrup, starch, gelatin and water, food acids, flavourings, and colourings. Pectin may also be used as a gelling agent. The ingredients are formed into different shapes by transferring into moulds. The major gelling properties are imparted by starch or gelatin. (Burey *et al.*, 2009).

Conclusion

Gels developed have food grade macromolecules are acceptable due to their biodegradability, biocompatibility. The developed products are nutritious, safe healthy and widely accepted. New types of gelled products like multi-component or mixed gels, aerated gels, and emulsion gels are the areas of research in future.

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Mechanism of Plant Resistance

Article ID: 40655

Mamta Joshi[1]

[1]Department of Entomology, College of Agriculture, G. B. Pant University of Agriculture and Technology, Pantnagar, 263145 (Uttarakhand).

Introduction

"The relative amount of heritable qualities possessed by the plant that influence the ultimate degree of damage done by the insect," according to the introduction (R. H. Painter, 1951). Four characteristics can be used to assess resistance. It is heritable, relative, measurable, and variable.

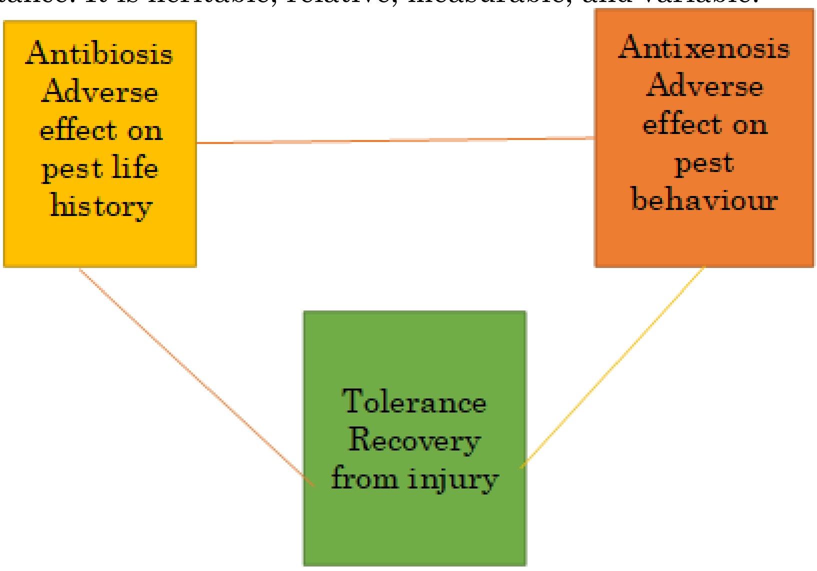

Fig: Mechanism of resistance in Plants

Plant Resistance Mechanism

"Non-preference or antixenosis are plant characteristics that drive insects away from a specific host."

Kogan and Ortman (1978) coined the term "antixenosis" to describe the host plant characteristics that cause non-preference.

Antibiosis: "The adverse effect of the host plant on the biology (survival, development or reproduction) of the insects and their progeny infesting it".

Failure to pupate Failure of adults to emerge from pupae Larval death in the first few instars Abnormal growth rates.

Tolerance: "The host plant's ability to withstand an insect population large enough to severely damage susceptible plants." Plant vigour Re-growth of damaged tissues Ability to produce additional branches Insect utilisation of non-vital parts Compensation by growth of neighbouring plants.

HPR has the Following Advantages

1. It is specific to the target pest.
2. Natural enemies are unaffected.
3. It is eco-friendly.
4. It is less expensive. Effectiveness.

Conclusion and Research Prospects

1. Several biophysical and biochemical plant traits are responsible for insect resistance. It prevents or mitigates yield loss.

2. Many plants secondary metabolites exhibit antifeedant, repellent, oviposition deterrent, growth regulatory, and insecticidal activity against a wide range of insects.
3. Because of their non-target organism and environmental safety, these will have the greatest impact in future integrated pest management (IPM) programmes.
4. Future research should concentrate on the long-term effects of climate change factors, as well as their interactions with plant secondary chemistry.

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Insect Pest Management in Black Gram

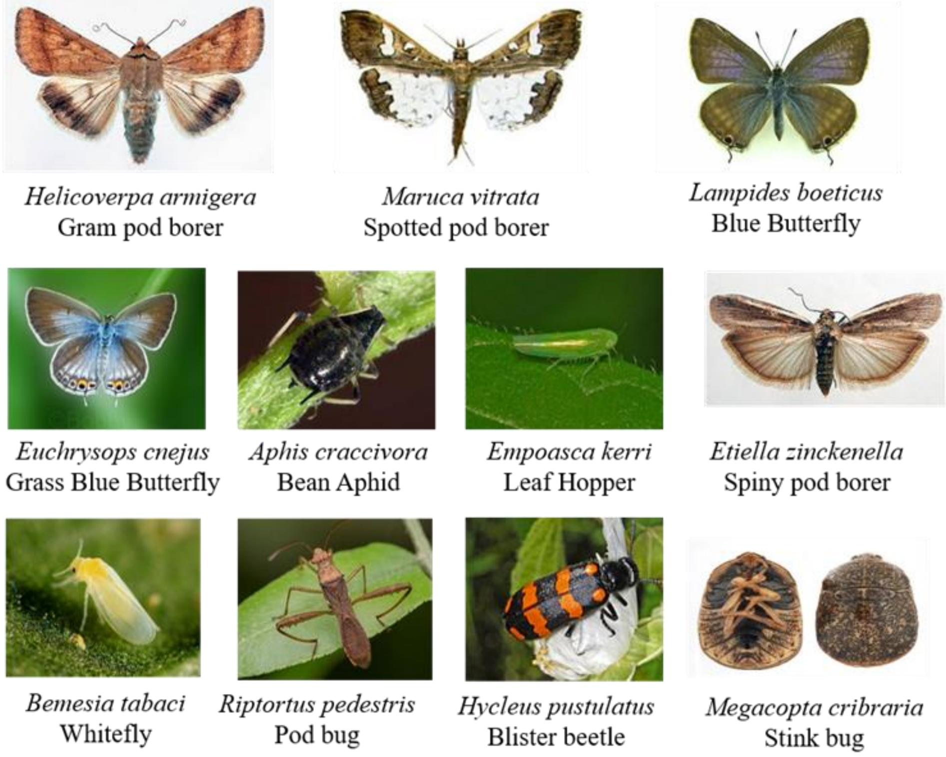
Article ID: 40656

R. Aarthi[1], B. S. Anand Babu[1], A.S. Karchikumar[1], P. Kavin[1], E. Mohamedfarook[1], R. Premika[1], S. Raman[1], M. L. Mini[2]
[1]M. Sc Scholar, [2]Associate Professor,
Agricultural College and Research Institute, Madurai, Tamil Nadu, India.

One of the widely cultivated pulse crops in India is the black gram (*Vigna mungo*). This crop is been cultivated in both the Kharif and Rabi seasons. Black gram is also called as mung bean, urad bean etc. Due to its high nutritional value with high contents of protein, potassium, calcium, iron, niacin, thiamine, riboflavin and folate, it is been used for making many traditional dishes. It is also used as nutritional fodder for milch animals. The crop has the ability to withstand adverse climatic conditions, and it improves the fertility of the soil by the fixation of nitrogen from the atmosphere. But some adverse climatic condition leads to the outbreak of pest that causes severe damage both in the nutritional content and also in the yield for the farmer.

Major Pests

Black gram is being attacked by beetles, leafhoppers, white flies, pod borers, etc. During infestation, the leafhoppers used to transmit the yellow mosaic viral disease. Proper management strategies have to be adopted for the effective control of the pests or it can ultimately lead to considerable decrease in the yield. Some of the major pest that causes damage to the crop extensively are given in the figure.



Common pests of black gram with scientific and common names

Management of Pod Borer Complex

1. Deep summer ploughing within 2-3 years to eliminate the pupa.
2. Practicing early sowing with short duration varieties.
3. Growing tall sorghum as the comparison crop that act as biological bird perches.
4. Collection and destruction of larvae and adults.
5. Installation of pheromone traps at a distance of 50 m @ 5 traps/ha.

6. Installing Bird perches @ 50/ha is effective in controlling the larva.
7. Monitoring and killing of moths by setting of light traps at a rate of 1 light trap/5 acre.
8. Release *Trichogramma chlionis* at weekly intervals @1.5 lakh/ha/ for four times at weekly intervals.
9. Application of Ha NPV 250 LE /ha with teepol 0.1% and Jaggery 0.5% thrice at 10 – 15 days interval commencing from flowering stage.
10. Spraying of NSKE 5% twice and followed by application of triazophos 0.05%.
11. Application of quinalphos 4D/carbaryl 5D at a rate of 25 kg/ha.
12. Spraying of insecticides like Quinalphos 25 EC @ 1000 ml/ha.

Integrated Pest Management

1. Cultural methods:

a. Practicing early sowing with short duration varieties.
b. Soil raking along the trenches and weeding reduces the population of soil grubs
c. Application of 50 kg potash/ha raised with closer spacing of 20 x 10cm reduces the pod borer incidence
d. Appropriate weeding practices.
e. Collect and destroy egg masses and pupae from the field to avoid pest outbreak.

2. Mechanical methods:

a. Collection and destruction of nymphs and adults for sap feeders.
b. Light trap to monitor, attract and kill pod borer moths
c. Pheromone traps @ 12 Nos/ha -reduce gram pod borer incidence.

Biological methods:

a. Release of egg parasitoid *Trichogramma spp*; egg larval parasitoid *Chelonus blackburnii* for - control of *H. armigera*
b. Application of Ha NPV @ 500 LE I ha to control *H. armigera*
c. Release of Larval parasitoids*, Hyperencyrtus lucoenephila* and *Litrodromus crassipes* for control of *Lampides* larvae.

Chemical methods:

a. For Sucking pests:
  i. Application of methyl demeton 25 EC 500 ml (or) dimethoate 30 EC 500 ml /ha
  ii. Dust 4% endosulfan or spray 0.05% dichlorvos or 0.1% malathion
b. For seed purpose: seeds can be admixed with 1 kg of activated kaolin or malathion 5% D for every 100 kg of seeds and packed in polythene lined gunny bags for effective storage.
c. Application of Neem seed kernel powder at 3% for the control bruchid beetles
d. Application of Carbaryl 50 WP@ 1000 kg / ha for the control of *Lampides* larvae.

Conclusion

Considering black gram as one of the staple and traditional food crops in India, pest management of this crop plays a major role in sustaining its nutritional constituents and increasing yield and productivity. The management practices are to be regulated in a judicial manner so that these control methods can be effective and cost-efficient and with very little or no risk to people or the environment.

Multi-Tier System

Article ID: 40657

M. Anand[1], P. R. Kamalkumaran[2], M. Velmurugan[3]
[1]Associate Professor (Horticulture), Tamil Nadu Agricultural University, Coimbatore.

Abstract

Multi-Tier System is the method of planting, different types of plants with different height and light intensities. In multi- tier system we utilize maximum unit area. Since we plant different kinds of plants we are able to obtain yield though out the year. It helps the farmer to remain distinct from others in profitable marketing. It helps in maximization of light harvest with effective utilization of Cubic Area accommodating different types of 1000 plants / acre. Hence this method fulfills the satisfaction of the planter and helps him to increase profit. It is a modern method of coffee cultivation involving planting of fruit tree and timber yielding trees for better light interception and ease of mechanized operations. It makes maximum use of land to achieve high yields in early periods of orchard life along with ease in its management. It is successful in coffee with pepper, orange, banana, avocado, Jack, cinnamon, allspice, timla fig, areca and timber yielding trees etc.

Introduction

Multi-tier cropping system involved in combination of plants with various morpho- phenological features to maximize the natural resource use efficiency and enhanced total factor productivity. Horticulture crops particularly fruit and plantation crops have self-sustainable system where solar energy can be harvested at different heights, soil resources are used efficiently and can increase cropping intensities. The system consists of three main components viz. main crops, filler crop and intercrops which occupy three different tiers in space of the production system. To ensure sustainable productivity and high returns from underutilized and stressed lands and to improve the soil characteristics multi- storey cropping system have been found successful in sub-tropical conditions. Multi storied cropping system in horticulture is found to be a perspective approach for sustainable productivity.

Under this system, black pepper trained on silver oak serves as first tier, mandarin orange in the middle tier. In this system cash crops like avocado, jamun and litchi could be inter cropped in the middle tier to increase the profitability of the tribal farmers. Moreover, these crops are playing a vital role in nutrition and livelihood for rural and tribal masses for employment and income generation.

In the present scenario the income from the current multitier system is fluctuating and very low. Diversification of plantations with compatible and remunerative crops like avocado, jamun and litchi along with black pepper, mandarin orange and hill banana in the high ranges of Western and Eastern ghats would be a boon to the tribal growers to increase the revenue level double the time. Cultivation of these associate crops is sure to improve not only the cash inflow of the growers, also aid to overcome the total dependence on monoculture.

As the rainfall is erratic in the recent past the yield from the existing plantation are not economical, the subsidiary crops in the middle tier viz., avocado, jamun and litchi improve the livelihood of farmers. Sustainable cropping systems in the plantations should involve successful management of natural resources like soil moisture and solar radiation to satisfy the changing needs of small and marginal farmers (below 2.0 ha).

It is also quite imperative to maintain or enhance the growing environment and conserve natural resources in the high ranges of Western Ghats and Eastern ghats in South India. Productivity of the plantations should be increased by intensive cultivation and resorting to diversification with suitable mixed crops to improve and sustain high income.

Avocado, litchi and jamun crops can grow in hill slopes at elevations upto 1,600 meters. With proper varietal selection, it is possible to exploit the off-season production also, thus enhancing the availability of fruits during the lean period of the year and fruits produced can be marketed without much difficulty, particularly to meet the requirement of the growing tourism industry by fetching a premium price.

Model Multitier System-1

Elevation - 4000 ft
Rainfall - 1500 mm
Relative Humidity - 60%

Crop	Number of plants	Yield/plant
Coffee (Arabica) (5x7 feet)	900	5 kg fruit
Mandarin Orange	115	500 fruits
Jack and silver oak	100	-----
Pepper vine	200	1kg dried
Total	**1315**	**-----**

Model Multitier System-2

Elevation - 3000 ft
Rainfall - 1500 mm
Relative Humidity - 65%

Crop	Number of plants	Yield/plant
Coffee (Robusta) (10x10 feet)	400	7 kg fruit
Banana (20 x 20 feet)	100	85 fruits/bunch
Jack and silver oak	100	-----
Pepper vine	200	1kg dried
Silk cotton	50	500 pods
Total	**1315**	**-----**

Conclusion

It has many salient features like a greater number of plants per unit area, minimization of weed population, more economic returns per unit area, minimum water usage, maximum job satisfaction, increased humidity and reduced harvesting charges. There is always a high possibility of pest and disease incidence in Multi-Tier System. Hence great care is to be taken to see that all plants obtain an optimum sunlight which would help in minimizing pest and disease incidence. Cultivation of these associate crops is sure to improve the cash inflow of the growers, thereby aid to overcome the total dependence on monoculture.

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Allahabad Surkha Guava: A Pride of Prayagraj District

Article ID: 40658

Deepak Lall[1], Vijay Bahadur[2]
[1]Ph.D. Scholar, Department of Horticulture, Naini Agricultural Institute (NAI),
[2]Vijay Bahadur, Associate Professor & Head,
Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS).

Abstract

Guava (*Psidium guajava)* considered as 'Apple of Tropics'. It is a shrubby evergreen tree grows up to a height of 10 m to 12 m as standard. The stem is hard, woody and brownish to reddish tinge in color with hard brown scaly bark. It bears white flowers and numerous pears to oval shaped fruits that are edible by animals, birds and humans. It is a shrub-like small tree that spreads profuse branching in various directions. It is cultivated for its fruits and shade purposes. Allahabad Surkha guava fruits are rich in Vitamin A, Vitamin C and pectin content. It is also used as medicine for various diseases. Leaves and bark of surkha guava are also used to prepare a medicine that helps to treat disorders of the digestive system, menstrual problems and to treat the diseases of the blood and immune system. The extract of guava leaves is anti-bacterial, anti-fungal in nature. Agriculture constitutes a large market for Indian food markets growers and processors which rank fourth in the world food market. Guava as 'poor man's fruit' has tremendous trade market. In India the guavas cultivated in the orchards of Allahabad City near the belt of Sangam enjoy a heavy demand due to their delicious taste named Allahabad safeda, surkha, apple guava and lalit etc. The present article aims to facilitate the importance of surkha guava for entrepreneurship development, industrialization, supply chain with respect to guava production and its processing by farmers or growers.

Introduction

In Sanskrit guava is referred as **'Jamphala'**, the word 'Jamphala' is also used in Ramayana. The whole fruit of this plant is edible. The fruit can be eaten raw or even cooked. Fruits are sliced and used as salads or desserts. Beverages are also prepared from the pulp of the fruit. Many varieties of guava is recommended for processing of value added products such as jam, guava paste, guava cheese and nectar etc. The leaves are also edible and have medicinal properties. Guava tree is a small shrub-like tree grows up to 10m-12m in height. It is a shady tree with white color of flowers. It is cultivated for its fruit and various medicinal uses.

Guava is considered as shrub like tree of the genus *Psidium* (family Myrtaceae) native to tropical America. The term "guava" appears to derive from Arawak guayabo which means "guava tree", whereas in Spanish it is called as guayaba. It has been adapted in many European and Asian languages, having a similar form. The common types of guava include red fleshed guava, apple guava, yellow fruited cherry guava, strawberry guava, and red apple guava. It is mostly eaten raw (ripe or semi-ripe) or consumed in the processed form of juice, jams, and jellies. The common guava has a fruit with a yellow skin and white pulp, yellow, or pink flesh. Guavas are known for their sweet and tangy flavor and many uses, but there's much more to this fruit than meets the eye. It is also consider as "magical or meticulous" fruit because of its array of nutrients and medicinal uses. *P. guajava* has a rich ethno-medicinal history. Different parts of the plant are used in various indigenous systems of medicine, primarily for the treatment of gastrointestinal disorders. Some of the ethno-medicinal uses includes the crushing of the leaves and the application of the liquid extract can cure wounds, cuts, ulcers, skin rashes and soft tissue infections and rheumatic problems. Guava trees are well adapted to a wide range of soil types including sands, loams, rock-based soils, muck degraded soils. A soil pH of 4.5 to 7.0 is ideal but guava plants do well in high pH soils ranges upto (7.0-9.0) if supplied with chelated iron materials. Guava trees found propagated through air layering or wedge grafting method, generally it has deep penetrated tap root system with most roots within 12 to 18 inches (30-45 cm) of the soil surface.


Major Producing Countries of Guava

Guava's believed to have originated from Mexico or Central America. It is now very popular in Asian countries and is also increasingly available in American countries, particularly after its health benefits have been revealed. The most guava producing countries are India, China, Thailand, Pakistan, Mexico, Indonesia, Brazil, Bangladesh, Philippines, and Nigeria. Globally, India, Pakistan and Brazil had been the principal producers of commercial Guava cultivars. Bangladesh is 8^{th} highest guava producing country.

Phenology (The Study of Phenomena or Happenings)

Psidium guajava plant flowers within first two years of its growth under suitable environmental conditions. The plant becomes a tree in 5-8 years depending upon the environmental conditions and space provided for its growth. It can live for not more than 40 years. The plant provides shelter to many birds and insects. The fruits are food for these birds and insects. The white colored flowers also attract insects and bees for nectar and pollination.

Medicinal Properties & Major Bio-Chemical Compounds of Guava

Guava (*Psidium guajava* Linn.) commonly known for its food and nutritional values throughout the world. A number of chemicals isolated from plants like quercetin, guaijaverin, isoflavonoids, gallic acid, catechin, epicathechin, rutin, naringenin, kaempferol flavonoids and galactose-specific lecithins have shown promising activity. Toxicity studies in mice and other animal models as well as controlled human studies show leaf, seed, pulp, skin and fruits different extract in different concentration are helps to prevent cancer, regulating blood pressure, and treating diarrhea. Much of the traditional uses have been validated by scientific research. The plant has been extensively studied in terms of pharmacological activity of its major components and the results show antioxidant, antipyretic, antifungal, antimicrobial, hypotensive, analgesic & anti-inflammatory effect.

Health Benefits of Guava

"Guavas or amrood is blessed with many nutrients by nature. Originally found in South America, this fruit was presumably brought to India by the Portuguese. Here are some of its health benefits:

Boost immunity: Guavas contain four times the Vitamin C content present in oranges. Vitamin C helps in improving your immunity and thus keeps your body healthy and protects it from pathogens that cause infections.

Improves hormonal function: Copper, present in guava, helps in the production and absorption of hormones. This property helps in improving the function of your endocrine system especially thyroid glands which is responsible for the way in which you metabolize food, use energy, etc.

Lowers risk of cancer: Being diagnosed with cancer can be a person's worst nightmare. Being rich in Vitamin C and antioxidants like lycopene, eating guavas can protect your cells from damage and reduce your chances of getting cancer. Additionally, Vitamin C boosts your immunity which is critical in fighting cancer cells.

Good for diabetes: Rich in fibre and with a low glycaemic index, guavas can be consumed by diabetics and those who want to prevent diabetes. When you have diabetes, your body stops producing insulin which is responsible for the absorption of glucose. Consuming fruits and vegetables rich in fibre is recommended.

Has an anti-ageing property for skin: Guavas are rich in Vitamin C, Vitamin A and antioxidants like lycopene and carotene which protect your skin from wrinkles and fine lines, thus making you look younger. Old-age is a certainty in everyone's life, and eating a guava every day can at least prolong the process.

Helps to treat constipation: Constipation is caused when food is stuck in our colon. Guava, is rich in fibre which helps in clearing the blocked pathway and thus curing your constipation.

Helps to improve eye vision: Even though, guavas are not as rich in Vitamin A as carrots, they still are still a very good source of the nutrient. Vitamin A helps to keep your eyes in good condition, and also helps to improve your vision. Night blindness is one of the diseases associated with a Vitamin A deficiency.

Good in pregnancy: Guavas contain Folic acid, or Vitamin B-9, which is recommended for pregnant mothers since it can help in developing the baby's nervous system and protect the newborn from neurological disorders.

Helps to relax and to reduce stress: Magnesium present in guavas helps in relaxing your nerves and muscles. In today's stressful times, consuming a guava to combat stress and relax is certainly a good idea.

Good for brain relaxation: Brain is one of the major organs of our body, and keeping it healthy should be on our priority list regardless of how intelligent we consider ourselves. Guavas contain Vitamin B3 and Vitamin B6, also known as niacin and pyridoxine, which helps in improving blood circulation to the brain and relaxing.

Importance of Allahabad Surkha Guava in Indian Context

Guava is a super fruit that ranks high on the safety index, which means that it gives a feeling of fullness for long. So, it's a good fruit snack option between meals. "Just one guava has about 3 grams of fibre (which is a lot!), and has just 40 calories. Guava is also rich in magnesium and Vitamin C — has four times more Vit C than an orange. The pink one (pink on the inside) has more lycopene and Vitamin A". What's more? Guava is a diabetes-friendly fruit, and "especially good for thyroid patients, as it is rich in copper. The guava of prayagraj is known as meticulous fruit with its genuine home in India. The Allahabad Surkha Guava is frequently referred to as a heavenly treat by all who have had the pleasure of eating it over since several years. The surkha guava is also meant for its puree jelly which is very popular for its attractive purplish-red colour, delicious taste and aroma. Further the puree can be used in different media like: juice, ice-cream, jam, jelly, cakes, puddings and sauces. Fruits of surkha can be preserved by canning as halves or quarters. Proper cultivation with the proper planning will give better result in term of healthy fruits with good economic value. According to the **"National Horticulture Board"** as it tolerates high temperatures and drought conditions prevalent in north India in summer. The geographical distinct is associated with various fruits, food products etc. Andhra is known for its Banganapalle Mangoes, Nagpur is known for its high-quality oranges, and City of sangam prayagraj is known for its abundant and lush variety of "guavas". Due to this, prayagraj is frequently referred to as **"The City of Green Gold"**. The Pectin, vitamin- C and A, folic acid, and many other nutrients are abundantly available in surkha guava fruit.

Nutritional Facts of Pink or Red Fleshed Guava

100 g of pink guava fruit provides 5204 µg of lycopene, nearly twice the amount than in tomatoes. (100 g tomato contains 2573 µg of lycopene). Various research studies suggest that lycopene in pink guavas prevents skin damage from UV rays and offers protection from prostate cancer. Fresh fruit is a very rich source of potassium. It contains more potassium than other fruits like banana weight per weight. Potassium is an important component of cell and body fluids that helps controlling heart rate and blood pressure.

Further, the fruit is also a moderate source of B-complex vitamins such as pantothenic acid, niacin, vitamin-B6 (pyridoxine), vitamin E and K, as well as minerals like magnesium, copper, and manganese. Manganese is used by the body as a co-factor for the antioxidant enzyme, superoxide dismutase. Copper is required for the production of red blood cells.

Specialty of Allahabad Surkha Guava

These are uniquely tinctured guavas found in limited supply with season-based production. The Allahabad's Surkha guava distinguished from other varieties by its apple-red stripes with tinges and spots over the peel or outer skin of the fruit and deep pink fleshy pulp from inside. The surkha guava is known as 'legend, mystique and charm of Sangam city prayagraj. It consist aroma with deep scented flavor, it has not only received the GI tag, but is also a part of the legend, mystique and charm of the geographically distinct triangular region of Sangam at Prayagraj where Ganga and Jamuna connect with the mythical Saraswati. It is believed that the cultivation of these guavas are more closer to the Sangam, due to which it has more vibrant hue of pink flesh deep inside! This is what makes Allahabad Sebiya or Allahabad Surkha unique, popular and different from other varieties of guava grown elsewhere. It has an apple-red exterior tinges or spot and it has succulent deep pink colour inside; hence, it is named as 'Surkha'. Its natural habitat for cultivation is associated with 300- 400 hectares of land found in Doab region in Kaushambi district. The Allahabad surkha guava is grown in two major blocks *viz.* Muratganj and Chail they have been declared as major 'fruit belt' by the state government of Uttar Pradesh. Both the Mission for the Integrated Development of Horticulture (MIDH) and its predecessor programme National Horticulture Mission (NHM) have extended support to better agronomic practices as well as micro-irrigation to have its precious commodity termed as fruit.

Every day throughout the season, about 50 tonnes of fruits are shipped to the states of Bihar, Jharkhand, West Bengal, and other state. Despite the recent name change to Prayagraj, the popularity of Allahabad guava hasn't changed over the years. In addition to the surkha, the safeda and narma kinds of Allahabad guava each have their own unique features and characters.

The interventions in Allahabad surkha guava also include with high-density plantations as modern urbanization through grafting into the core area of Surkha production belt in prayagraj. The Surkha amrud can be grown only in and around Sangam region. The guava is special for the residents, tourists and pilgrims due to its remarkable fruit appearance, taste, quality, flavor and texture. Allahabad are known to send guavas as festive gifts to the relatives especially in winter season as peak season of quality fruits (November-February); and it is more cherished than dry fruits or sweets because of its seasonality and limited availability.

To place the guava production in perspective, let us understand that compared to the production of the **3.0 lakh thousand MT of bananas, and 2.0 lakh thousand MT of mangoes**, the third, fourth and fifth highest fruit crops in India, *viz* papaya, mandarin oranges and guava are way behind at **6.0 thousand, 5.0 thousand and 4.0 thousand MT** respectively. The production of guava is concentrated in the states of Maharashtra, Bihar, UP and West Bengal – but nowhere does the fruit have 'surkha colour and flavour'. The craze for Allahabad guava remains unaltered over the years even with the recent name change to Prayagraj.

In addition to this, Allahabad Surkha guava also has its own identity in comparison to other varieties like Allahabad Safeda and Narma . Out of these varieties, Allahabad Safeda has the maximum production. It has yellowish white to off white juicy firm pulp, it has round shape, soft-smooth skin, pleasant taste & flavor, and is grown across the subcontinent. This is also the preferred variety for processing and confectionary preparations (jellies, jams and juices).

Due to its delicious flavor and pleasant aroma, Allahabad Surkha Guava was awarded the **Geographical Indication Tag (GI) in 2007–2008** and continues to be a favourite among people. However, it is only the Surkha Guava that applied for, and received the GI tag way back in 2008. The GI is held by the producers themselves under the banner of the Allahabad Surkha Amrood Utpadak Welfare Association. The application made to the GI registry stated: "the famous apple-coloured guava variety, Allahabad Surkha, though not a native race of India, originated as a chance seedling in the village Abbubakarpur in the Allahabad district".

Nutritional Case Study of Guava

Guava is highly nutritious and a good source of calcium, iron, and phosphorus. The vitamin C content of guava fruit is 2–5 times more than that of citrus. The plant has many medicinal properties mainly due to its bioactive phyto-constituents. Guava is processed into a number of products like juice, jam, and jelly to extend its availability throughout the year. The white-fleshed guava is high in antioxidants, and the red-fleshed variety is even higher. Red- and pink-fleshed guavas, gram for gram, have more lycopene than even watermelon and tomato. A study from the **Heart Research Laboratory in India** found that people who ate five to nine pink fleshed guavas per day for three months reduced their cholesterol levels by 10%, their triglycerides by 8% and their blood pressure by 9.0/8.0mm Hg, while also boosting their HDL (good) cholesterol by 8%. Along with the antioxidant phytochemicals and vitamin C that prevent the oxidation of LDL, guava also offers fiber and potassium, which make it especially healthy for the heart.

Conclusion

Guava is an exquisite, nutritionally valuable, and remunerative fruit crop of tropical and subtropical regions of the world. Guava cultivation became a commercial preposition in recent years, due to its high nutritive value and popular processed products. India is the world's largest producer of guava followed by China and Kenya. This popular fruit is a powerhouse of nutrients. Traditionally its says that **"An apple a day keeps the doctor away" in Europe and Americas,** the phrase is probably changed to **"A few guavas in the season keeps the doctor away for the whole year"** in the Indian sub-continent and places where guavas typically grow.

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Timla Fig (*Ficus auriculata*) Propagation and Cultivation

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P. R. Kamalkumaran[1], M. Anand[2], M. Velmurugan[3]
[1]Agricultural College and Research Institute, Keezhvelur, Nagapattinam.
[2,3]Tamil Nadu Agricultural University, Coimbatore.

Abstract

Ficus, the fig genus, consists of over 800 species in 40 genera of the mulberry family, Moraceae. *Ficus auriculata* commonly known as Elephant Ear Fig, Roxburgh's Fig, Coconut Strawberry Fig, Giant Indian fig, Himalaya fig is a type of fig tree seen all over Asia, noted for its big and round leaves and more delicious edible figs (fruits). A deciduous woody tree, having a short trunk, which soon divides into a few stout laterals, which further- branch irregularly, spreading in all directions; height. 10-12 metres; bark, smooth, gray, with a tinge of yellow or green. It grows best in areas where annual daytime temperatures are within the range 15 - 25°c, but can tolerate 12 - 32°c. Though the bearing of the fruit starts from the 2nd year, fruits are harvested from the 3rd year onwards. The yield increases with increase of the canopy size of the tree and stabilizes on 8th year. The economic life of the plant may be considered 35 years. The harvesting season in Sheveroy hill is June-Aug. The fruits are harvested once in 2-3 days manually.

Introduction

Fig plant is widely distributed in temperate, tropical and subtropical regions of about 1800-2600 m altitude. It has abundant amount of white latex in every part of the plant. Bark is grayish brown with rough texture. Branchlets are reddish brown. It can also easily be trimmed and the plant reacts with even more shoots and leaves on a thicker stem. Auriculata means, ear-like. The young evergreen leaves are starting intensely red, and turn more and more green when reaching their ultimate size of up to 50 cm length. Figs fruits are reddish brown, pear shaped, globose or top shapered in nature and generally occur on short specialized leafless branchlets at base of trunk and main branches.

Utilization

The fruits are very good for eating and the jelly-like substance contained in them makes them very tasty. The fruits should be very suitable for bottling, and work should be initiated on this aspect. The possibility of jam-making from this fruit should also be explored. The leaves are used as a fodder during the winter season and are very much liked by cattle. The leaves are also used as plates by stitching 3-4 leaves together for taking food during feasts in the villages

Botanical Description: Small trees; branchlets brownish, hollow; latex milky. Leaves alternate, (orbicular-) ovate, to 40 x 30 cm, subcoriaceous, base cordate, apex acute, pubescent along nerves below, with glands in the axils of main basal nerves; petiole to 5 cm; stipules ovate-lanceolate, 2 cm. Figs cauliflorous, on short shoots from trunk or main branches, turbinate, subtended by 3 ovate, basal bracts; orifice covered by 3-angular bracts 6 mm; peduncle to 2.5 cm. Staminate: in several rows towards the ostiole. Tepals 3. Stamens 2, basally connate. Gall flowers below the staminate. Pistillate: Perianth 2-or 3-lobed. Ovary 1-celled; ovule 1; style thick, simple, subterminal, hairy. Fig turbinate, 6.5 cm wide, ribbed, brown hairy.

Climate and Soil

It performs well in arid and semi-arid regions under open sunshine and can tolerate moderate winter conditions. In tropical areas generally, figs thrive between 2,600 and 5,900 ft (800-1,800 m). It grows best in areas where annual daytime temperatures are within the range 15 - 25°c, but can tolerate 12 - 32°c. Though the plant can thrive in high temperature regimes (upto 45°C), the fruit quality deteriorates beyond 39°C and premature ripening sets in. Mature trees can withstand 4°C, but young trees need protection from frost. Fig trees grow well on a wide range of soils but do best in deep non alkalaine clay loam. Medium to heavy calcareous, alluvial clay loam which are well drained but with good moisture holding capacity are ideal for fig cultivation well drained, is suitable for cultivation of Fig. Though the crop does well in sandy soils, deep soils encourage better Root Establishment. The Crop Is Sensitive to Sodium and Boron Salts.

Varieties

YCD.1 TIMLA FIG (1993) It is an introduction and released from Horticultural Research Station, Yercaud. The trees are well adapted to the rainfed situations of Shevroys hills and to the poor shallow and rocky soils. The trees are suited to growing in home gardens and parks. The trees showed high drought tolerance besides its exceptionally hardy nature and free from any pest or disease including the common fig rust.

The plants are spherical in canopy and are elegant with dense dark green leaves often growing to a height of 7.0 m with a spread of 12.0 m. Fruits are in attractive reddish-purple color and are large in size measuring 7.0 cm in diameter, each weighing 100-200g. Higher harvests are made from each tree, the maximum being 4000 fruits. The bearing is throughout the year excepting winter months. Fruits are a rich source of vitamin C (500 mg/100g) besides ß carotene and lycopene.

Propagation

Timla Fig is commercially propagated through air layers. swabbing of IBA @ 3000 mgl^{-1} on the peeled area of semi hardwood shoots with optimum girth of 10-14 mm thickness recorded significantly highest percentage of hardened air layer in timla fig (64.07%) with the benefit cost ratio of 3.48. The percentage of hardened air layer and Benefit cost ratio in control is 39.63% and 1.75 respectively.

Procedure:

a. Selection of semi-hard wood shoot of previous year growth
b. Shoots with optimum girth of 10-14 mm thickness should be selected; Weak and crowded shoots should be removed to make room for layering in the selected shoots.
c. Excess defoliation should not be done which may weaken the tree
d. Incision should be made 1 foot below from the tip of the shoot and leave 5-10 cm gap from the origin of the shoot
e. Bark should be peeled off from 20 mm width incision made on the shoot
f. Swabbing of IBA @ 3000 mgl^{-1} on the peeled area of the semi hard wood shoot
g. Coir pit soaked in water has to be placed over the cut surface after squeezing the excess moisture
h. Wrapped with poly sheet and both ends should be tied with either thread or tape
i. The half cut should be given 60 days after layering
j. The layer can be detached from the tree after 90 days
k. The air layers after separation from the mother plant is hardened for a period of 25-30 days before planting in the main field.

Planting

Cuttings are raised in nursery beds and are set out in the field after 12 or 15 months. Generally, a spacing of 8 x 8 m is kept. Pits of 60 cm^3 dug at least a month before planting and are filled with a mixture of FYM or Compost and garden soil before planting. Young plants will benefit from shading with palm fronds or other material until they are well established. Irrigation should be given immediately after planting.

Irrigation

Fig plants can sustain heat and drought. However, timely irrigation is required for the production of higher yield and hence, in commercial plantation, irrigation is done when the soil moisture reaches 50% pan evaporation. Loose and sandy soil require larger quantities of water. In the conventional mode of irrigation, flood irrigation at 10-day intervals is adopted during summer. The frequency of irrigation is adjusted depending on the soil type and climatic condition. About 15-20 litres of water is required per plant per day and this is adopted when irrigated through drip system. Excessive irrigation leads to terminal shoot development at the expense of fruit development; hence, it is necessary to avoid excessive irrigation. Heavy irrigation should be avoided during ripening of fruits, otherwise it may lead to frit splitting and production of insipid fruits.

Manuring

Nutrient requirements vary according to the variety and soil type. For young plants, fertilizers can be applied with the onset of monsoon and just after pruning for those which have commenced yielding. The annual requirement can be best divided into two applications, half after pruning and remaining two months later when the synconia are developing. Nitrogen is essential for rapid growth of foliage and development of syconia, fruit colour and maturation and K for yield and quality. Better fruit quality can be achieved if N and K are applied in the form of ammonium sulphate and sulphate of potash.

Recommended Dose of Manures and Fertilizer

Age of plant (Year)	Organic manure (kg)		Inorganic manure (g)		
	Farm Yard manure	Oil cake (Neem cake)	N	P	K
1-2	15	0.5	75	50	50
3-5	25	1.0-1.5	150	100	100
Above 5	40	2.0	300	200	200

Some soils may be deficit in micronutrients. The following guidelines should be followed for correcting the same guidelines. However, a grower should get the soil tested and consult the soil specialist for specific advice. Application of compost, which is done mostly in the beginning of monsoon also supplies micronutrients to some extent. Micronutrients to be applied for correcting deficiencies:

Micronutrient	Soil application	Foliar application*
Zinc	30 kg ZnSO4	3-4 sprays of 25 % ZnSO4 (Unneutralized) at 10 days interval
Iron	-	3-4 sprays of 0.5% FeSO4 at 10 days interval
Boron	12 kg Borax/ha	-
Magnesium	50 kg MgSO4/ha	2-3 sprays of 0.5% MgSO4 at 10 days interval

Training and Pruning

Fig trees are productive with or without heavy pruning. It is essential only during the initial years. Trees should be trained according to use of fruit, such as a low crown for fresh-market figs. Fig trees are trained initially to a single stem to encourage a wide, symmetrical crown with a mechanically strong framework having evenly distributed laterals. The tree is allowed to grow for about a metre and then it is topped, which induces side branches all-round the main stem. The interior of the bush should be maintained free of suckers, dry and sick branches. Pruning in fig is practiced annually to stimulate production of new growth. The time and type of pruning vary with location, variety and number of crops harvested annually. The best time to secure a mature crop is hot, dry summer. Copper fungicide should be used to protect the cut ends.

Harvesting and Yield

The flower type of common fig is pistillate and fruit develops parthenocarpically without the act of pollination. Though the bearing of the fruit starts from the 2nd year, fruits are harvested from the 3rd year onwards. The yield increases with increase of the canopy size of the tree and stabilizes on 8th year. The economic life of the plant may be considered 35 years. The harvesting season in Sheveroy hill is June-Aug. The fruits are harvested once in 2-3 days manually. The fruits are picked from the tree when they turn green to purple for distance market and gathered after they fall to the ground for local market. Harvested fruits are spread out in the shade for a day so that the latex will dry a little.

Conclusion

Fig is the deciduous woody tree, having a short trunk, which soon divides into a few stout laterals. Leaves, exstipulate, petiolate, each having 8.5 cm-long petiole, deciduous, obtuse, cordate, entire to undulate, alternate, 21.5 cm long, 23.5 cm. broad, having reticulate venation.Flowers, unisexual; inflorescence, hypanthodium, both the male and female flowers are borne on the fleshy receptacle.Fruit, technically a synconium, globose, having a 4.5-cm-long stalk, 4.5 cm in diameter. 30.55 g in weight, 30.12 ml in volume; the apical opening of the fruit, guarded by scales; mature fruits, yellowish to purple; pulp, light red. The fruit contain seeds, numerous, very small and range in number from 30 to 1,600 per fruit. The yield increases with increase of the canopy size of the tree and stabilizes on 8th year. The economic life of the plant may be considered 35 years.

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Breeding For Chilling Stress

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Devesh Yadav[1]

[1]Research Scholar, Department of Genetics and Plant Breeding, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur.

Crops grown in open environments frequently experience abiotic stress during their life cycle. Such stresses frequently overlap, affecting crop growth and productivity. In order to mitigate such abiotic stresses, plants undergo a series of morphological, physiological, biochemical, and molecular changes. Chilling stress is a common problem in agriculture, especially for crops grown in temperate climates. This stress occurs when plants are exposed to low temperatures, often below 10°C, for extended periods of time. This can cause a variety of problems, including reduced growth and yield, altered development, and even death of the plant. As such, breeding for chilling resistance has become a critical aspect of crop improvement. The goal of breeding for chilling resistance is to produce crops that are able to withstand low temperatures without experiencing significant stress. This can be achieved through a variety of methods, including conventional breeding, molecular breeding, and genetic engineering.

Amelioration of Chilling Injury

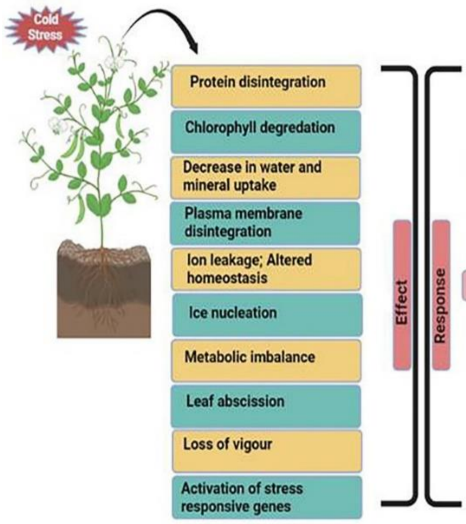
Avoidance: To avoid chilling injury, planting dates can be altered though this is often difficult because of its effect on later development of the plant. To overcome this problem, cultivars have been bred for early vigour and maturity. Investigations have also been undertaken to examine synthetic plant growth regulators for the protection of chilling sensitive crops (Li 1989).

Temperature conditioning: Low-temperature 'hardening' allowing tolerance to chilling temperatures appears to have little effect although some sensitivity to 'slight chilling' can be reduced by exposure to temperatures slightly above the chilling range. It has also reported that chilling injury to stored fruits and vegetables can be improved by warm temperatures if they are applied before significant tissue degeneration. Other treatments such as waxing, fungicides, hormones, and antioxidants have produced variable results that have been dependent upon the species and treatment conditions (Lyons 1973).

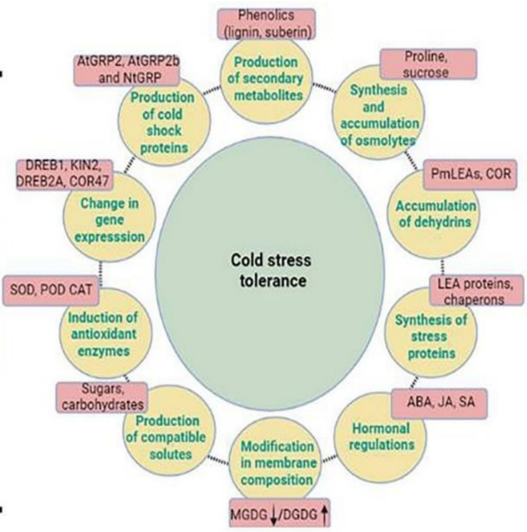
Duration: Ultrastructural-chilling injury increases with time and with prolonged exposure the injury becomes irreversible. It is therefore important to minimize the time of chilling temperature exposure.

Relative humidity: High (100%) relative humidity has been found to protect chloroplasts from chill injury, an effect that is enhanced by darkness.

Breeding Strategies



Major alterations due to cold stress in plants (physiological, biochemical, morphological and molecular)



Fundamental mechanisms to cold stress tolerance by plants

Conventional breeding involves crossing plants that are naturally resistant to chilling with those that are susceptible. This is done in order to transfer the desirable trait of chilling resistance to the susceptible varieties. Selection for the desired trait is then performed over several generations to produce a population of plants that are highly resistant to chilling stress.

Molecular breeding is a newer approach that involves the use of genetic engineering techniques to introduce specific genes into crops that confer chilling resistance. This can be done through methods such as transformation, where a desired gene is inserted into the plant's genome, or cisgenesis, where a gene from the same species is introduced. The molecular approach for breeding for chilling stress involves the use of genetic engineering techniques to introduce specific genes into crops that confer chilling resistance. This approach can be seen as an improvement over conventional breeding methods because it allows for the precise introduction of genes that are known to be involved in the plant's response to cold stress, thereby increasing the efficiency of the breeding process.

One of the key molecular techniques used for breeding for chilling stress is genetic transformation. This involves introducing a desired gene into the plant's genome, which can then be passed on to future generations. The gene of interest can be sourced from other plant species or can be a synthetic construct created in the laboratory.

Another molecular approach is cisgenesis, which involves the introduction of a gene from the same species into the plant's genome. This approach is particularly useful for crops that are difficult to genetically transform, as it does not involve the introduction of foreign DNA.

Once the desired gene has been introduced into the plant, it can be expressed in a tissue-specific manner, such as in leaves or stems, to enhance its effect on the plant's response to cold stress. The expression of the gene can also be regulated, so that it is only expressed when the plant is exposed to low temperatures.

In addition to genetic transformation and cisgenesis, other molecular techniques, such as gene editing and RNA interference, can also be used to breed for chilling resistance. For example, gene editing can be used to introduce specific mutations into the plant's genome that enhance its ability to withstand low temperatures. RNA interference can be used to silence specific genes that are involved in the plant's response to cold stress.

Another approach to breeding for chilling resistance is the use of genetic engineering. This involves the manipulation of a plant's genetic material to confer resistance to low temperatures. For example, researchers can introduce a specific gene into a crop that is known to be involved in the plant's response to cold stress. This can result in the plant becoming more tolerant to low temperatures, which can in turn lead to increased growth and yield.

So, the molecular approach to breeding for chilling stress provides a powerful tool for crop improvement, as it allows for the precise introduction of genes that confer chilling resistance. This approach has the potential to lead to the development of crops that are more efficient and resilient to cold stress, thereby increasing yields and improving food security.

Achievements

Conventional breeding has been instrumental in developing chilling tolerant cultivars in various crops (Jha *et al.*, 2017). Various rice varieties, e.g., 'Koshihikari' in Japan, 'Silewah' in Indonesia and 'Padi Labou Alumbis' in Malaysia were released for chilling stress tolerance by conventional breeding method (Ahmad P. *et al.*, 2014). Based on both open air and controlled conditions, Rodriguez *et al.* (2007) reported that 'EP80 × Puenteareas' population in maize was an important source of low temperature tolerance. Implementation of the modern omics approaches and identification of QTLs/genes for chilling tolerance can significantly support crop improvement strategies aimed to develop high yielding cultivars under low-temperature condition (Ahmad P. *et al.*, 2014; Jha *et al.*, 2017). In rice, selection using different parameters led to the development of low temperature tolerant genotypes such as 'HSC55,' 'M103,' and 'Jyoudeki' based on low spikelet sterility (Farrell *et al.*, 2006; Ye *et al.*, 2009). Suh *et al.* (2010) reported that phenotyping selection and SSR makers' identification methods are helpful in screening of plant genotypes against chilling stress. They found three QTLs responsible for seed setting percentage under chilling stress by using a recombinant inbred line (RIL) population developed by tropical japonica × temperate japonica.

Conclusion

In conclusion, breeding for chilling resistance is a critical aspect of crop improvement, especially in temperate climates. This can be achieved through conventional breeding, molecular breeding, and genetic engineering, each of which offers unique advantages and disadvantages. Nevertheless, the ultimate goal is to produce crops that are able to withstand low temperatures without experiencing significant stress, which can lead to increased growth and yield.

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Coffee for Subtropics

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M. Anand[1], M. Velmurugan[1], P. R. Kamalkumaran[1]
[1]Associate Professor (Horticulture), Tamil Nadu Agricultural University, Coimbatore.

Introduction

Coffee, native to Ethiopia, was introduced into India sometime during 1600 AD. Now coffee cultivation is mainly confined to the states of Karnataka, Kerala, Tamilnadu and Andhra Pradesh and on a limited scale to Arunachala Pradesh, Assam, Madhya Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Orissa, Sikkim, Tirupura and West Bengal. Though the genus Coffea consists of about 70 species, only three species are of economic importance. They are (i) *C. arabica* (Arabica coffee) (ii) *C. canephora* (Robusta coffee) (iii) *C. liberica* (Tree coffee). The first two species are extensively cultivated.

Arabica Coffee

The *C.arabica* is a small tree with dark green leaves. The flower buds are produced during October – March and flowers blossom 9-10 days after the receipt of blosoom showers. Arabica is self-fertile. The fertilized ovary grows into a fruit in 8-9 months.

Robusta Coffee

The *Coffea canephora* is bigger tree than Arabica. Flowers per clusters are more. It is a lowland coffee with wider geographic distribution. It grows under relatively more open and humid conditions than Arabica.

Tree Coffee

The *Coffea liberica* is a large bearing big broad, dark green and leathery leaves. The flowers and fruits are larger and take one year to mature. The ripe fruits are yellow to reddish- brown in colour.

Varieties

The selections and introductions were further improved by employing pure-line breeding, intervarietal crossing, back-crossing and interspecific hybridization. The selections were released for cultivation after zonal assessment.

Arabica Varieties

Selection 1 (S 288): This variety is a tetraploid hybrid derived from S-26 which is supposed to be a progeny of natural cross between' C. *liberica* x C *arabica.* It is resistant to leaf rust race I and II. Though this is a high-yielder with quality similar to Arabica, seed abnormalities are very frequent. However, because of its wide adaptability to varied agroclimatic conditions, it is still being cultivated in some areas.

Selection 3 (S-795): It is a cross-bred line of S-288 x Kents. Kents is a selection made by Mr Vent, a planter. It is resistant to two races of leaf rust and has bold fruits and seeds of good quality. The variety is resistant to race I and II of leaf rust. It has a yield potential of 700-1,200 kg clean coffee/ha with 75%; "A" grade and cup quality 5-6.

Selection 5: It "is derived from a cross between Devamachy x S-881 (wild Arabica from Rurne Sudan. Devamachy is a spontaneous hybrid of Robusta x Arabica sported in Coorg, It has small, oblong, leathery leaves and oblong fruits and seeds. It has a yield potential of 900-1, 100 kg clean coffee/ha.

Selection 6: A hybrid between S-274 (Robusta) x Kents. Its plants are larger with Robusta type branching. Fruit is medium to bold with cup quality similar to Arabica. It has a yield potential of 900-1,000 kg clean coffee/ha with high "A" grade beans.

Selection 7: Derived from San Ramon (a dwarf Arabica variety from Columbia) crosses. San Ramon was crossed with S-1406 to obtain Selection 7.1. Selection 7.2 is a cross between dwarfs of 7.1 x Agaro. This hybrid when crossed with Hybrids-de-Timor, Selection 7.3 was obtained. Selection 7.3 shows high resistance to leaf rust. Its plants are dwarf.

Selection 8: It is derived through pure-line selection of Hybrido-de-Timor (HDT). It shows the highest resistance to leaf rust. It produces drooping branches, bears moderately bold fruits with quality similar to Arabica.

Selection 9: Cross-bread line of Hibrido-de-Timor x Tafarikela, its plants are drought hardy. Bean is medium to bold. Nearly 70% of the plants in the progeny are resistant to rust.

Selection 10 *(Caturra crosses):* Caturra is a'dwaft type in Arabica. Some crosses of Catura with S 795, Cioccie and Hibrido-de-Timor show resistance to many races of rust.

Selection 11: Progeny of *C. liberica* x C. *engenoides.* Its plants show field resistance to rust and drought hardiness.

Cauvery

It is derived from Catimor lines which is a cross between Caturra and Hibrido-de-Timor. The plants are dwarf and highly suitable for high-density planting. It shows high degree of synchronised flowering, fruit set and fruit ripening. It shows a high yield potential of 1,000-2,000 kg clean coffee/ha. It produces more A grade coffee with superior cup quality.

Climate and Soil

The optimum soil and climatic requirements for Arabica and robusta under South Indian conditions are as follows:

	Particulars	Arabica	Robusta
1.	Elevation	1000 – 1500 m MSL	500 – 1000 m MSL
2.	Annual rainfall	1600 – 2500 mm	1000 – 2000 mm
3.	Blossom rain	March – April (2.5 to 4.0 cm)	February – March (2.0 to 4.0 cm)
4.	Backing rain	April – May (5 to 7.5 cm)	April – May (5.0 – 7.5 cm)
5.	Shade	Needs medium to light shade depending on elevations and aspects	Needs uniform this shade
6.	Temperature	15 – 25°C (ideal) (cool equable)	20 – 30°C (ideal)
7.	Relative humidity	70 – 80%	80 – 90%
8.	Soil	Deep friable, porous, rich in organic matter moisture retentive, slightly acidic pH 6.0 to 6.5	Same as for Arabica
9.	Aspect	Northern, Eastern and N. Eastern aspects are ideal	Flat to gentle shapes
10.	Slopes	A gentle to moderate slope is ideal	Gentle slopes to fairly level fields are to be preferred

Coffee cultivation is confined mostly to the hilly tracts of Western and Eastern Ghats. A well distributed rainfall is preferable for coffee with a dry month from December -March. Summer showers are important for flowering and failure of blossoms showers leaders leads to crop loss.

Nursery

Coffee is propagated by seed. Seeds are sown in December - January in the bed 1.5 - 2.5 cm apart with the flat side down wards in regular rows. Then they are covered with a thin layer of fine soil and a layer of paddy straw. Water the beds daily and protect from direct sunlight by an overhead pandal. Seeds germinate in about 45 days after which they are transplanted to a secondary nursery bed for raising ball or Bag nursery. Seedlings of minimum of 6 to 8 dark green leaves are to be selected for planting.

Planting

Spacing for arabica and robusta coffee is 2 to 2.5 m and 2.5 to 4 m respectively on either way. A close planting at 1-1.5m either way and reduce the population by half after one or two harvests is good. Pits of 45 cm, are usually opened after the first few summers shower and seedlings of 16 to 18 months old are planted during June or September-October. The seedlings are provided with cross stakes to prevent wind damage.

Training and Pruning

Training of the bush is necessary to have a strong frame work which promotes production of bearing wood.

Shade and its Management

Under the climatic conditions existing in India, Coffee is being cultivated under shade. Therefore, there is necessity for protecting the coffee plants during the above period by providing both temporary (lower) and permanent (upper) shade trees.

Dadap (*Erythrina lithosperma*) is used as a lower canopy shade in India. It is planted along with coffee in new clearings. Next to dadap, silver oak (*Grevillea robusta*) is the most commonly used tree for permanent shade. Permanent shade trees are generally planted about 12 to 14 metres apart.

Manuring

Crop	Pre-blossom March	Post blossom May	Mid-monsoon August	Post-monsoon October	Total
ARABICA ($N:P_2O_5 : K_2O$)					
Young coffee 1st year after planting	15:10:15	15:10:15	--	15:10:15	45:30:45
2nd and 3rd year	20:15:20	20:15:20	--	20:15:20	60:45:60
4th year	30:20:30	20:20:20	--	30:20:30	80:60:80
Bearing coffee 5 years and above for less than one tonne/ha. crop	40:30:40	40:30:40	20:0:0	40:30:40	140:90:120
For one tonne/ha. and above	40:30:40	40:30:40	40:30:40	40:30:40	160:120:160
ROBUSTA ($N:P_2O_5 : K_2O$)					
For less than 1 tonne/ha. crop	40:30:40	--	--	40:30:40	80:60:80
For 1 tonne/ha. and above	40:30:40	40:30:40	--	40:30:40	120:90:120

Harvesting

Coffee fruits should be picked as and when they become ripe to get better quality. Arabica comes for harvesting earlier since they take 8-9 months for fruit development from flowering while robusta takes 10-11 months. Picking is done by hand. The first picking consists of selective picking of ripe berries often seen in the outer portion of the node and is called fly picking. Thereafter, there will be 4-6 main pickings at 10-15 days intervals and final harvest ie., stripping consists of picking of still remaining green berries on the plant. Yield will around 750 - 1000 kg dry parchment /ha.

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Seed Production Technology of Bottlegourd [*Lagenaria siceraria* (Mol.) Standl.] in India

Article ID: 40662

Rahul Kumar[1], Preeti Vashisht[1], Gagandeep Singh[1]
[1]Ph.D. Scholar, Chaudhary Charan Singh Haryana Agricultural University, Hisar.

Introduction

Bottle gourd (*Lagenaria siceraria* (Mol.) Standl.) is one of the most important crops in the cucurbitaceae family. The fruits of bottle gourd can be used as a vegetable or for making sweets (e.g. halva, kheer, pedha and burfi) and pickles. A decoction made from the leaf is a very good medicine for curing jaundice. The fruit has a cooling effect, it is a cardiatonic and diuretic. The plant extract is used as a cathartic and the seeds are used in dropsy. The seeds are a rich source of essential amino and fatty acids. It is commercially cultivated in the Indo-gangetic plains of northern India as a summer crop. In rainy season, it is almost equally distributed in plains, lower hills and plateau region. In India, this crop is mainly cultivated in Uttar Pradesh, Punjab, Gujarat, Assam, Meghalaya and Rajasthan.

Climate

It is warm season crops grown mainly in tropical and sub-tropical regions. The bottle gourd is a typical tropical plant which requires a hot and humid climate for the best growth. The optimum temperature for growth 24°-27°C. It is highly sensitive to photoperiod. The day and night temperature of 30-35°C and 18-22°C respectively is optimum for its proper growth and fruit set. Short days and humid climate promote femaleness.

Land Requirement

The land selected for seed production should be free from volunteer plants, wild species and objectionable weeds. The land should be deep, well-drained, structurally stable, and well fertile with high pore volume. High porosity and solidity are important for coping with high and regular water supply, as well as with stress due to cultural practices and harvesting. This can be accomplished by incorporating bulk of organic matter and adopting proper tillage measures.

Seed Selection

Seed selection is the first step in production of quality seed. Select seed of improved variety of crop and use appropriate class of seed from authentic source for quality seed production. Further, the seeds must be free from pest and diseases. Seeds of uniform shape and size alone must be used for sowing. For bottle gourd some improved varieties are recommended: Pusa Naveen, Pusa Summer Prolific Long, Kalyanpur Long Green, Kasi Ganga, Arka Long, Punjab Long, Narendra jyoti, Pusa Summer Prolific Round, Punjab Round, Pusa Sandesh, Pusa Komal, Pusa Sandesh, CO-1**,** Pusa Santhusthi.

Seed Treatment

Seed should be soaked 18-24 hrs in clean water and treat the seed with Thiram or Bavistin @ 2.5g/kg seed to protect the young seedling from soil borne fungi.

Time of Sowing

Bottle gourd can be grown in summer and rainy season. But for seed production Kharif season is considered better the summer season. In summer, the crop sown in Feb-March and in rainy season (June-July and Oct- November). Sowing/planting should be done in furrow method instead of flat bed.

Seed rate (Kg/ha): The recommended seed rate is 4-5kg/ha for open – pollinated varieties whereas for hybrid seed production 3.5 kg seed of female parent and 1.5 k seed of male parent.

Spacing: The recommended spacing is 3-4m between two rows and 60-100cm between two plants. In Punjab, spacing of 2.5 x 2.0m is recommended for bottle gourd. In Maharashtra, bottle gourd is trained on bowers and sown at 3.0 x 1.0m distance. In West Bengal and South India sowing is done in pits. Pits of 90cm width, 60cm depth and of convenient length are dug and filled with well-rotted farmyard manure, followed by top soil.

Isolation Requirements

Bottle gourd is cross pollinated crop and honeybees are major pollinator, so for pure seed production an isolation distance all around seed field is necessary to separate it from fields of other varieties, fields of the same variety not confirming to varietal purity requirement. The isolation distance of 400 m for Certified Seed and 800 m for Foundation Seed and as a minimum of 1000 m isolation is required for breeder seed production.

Nutrient Management

Manure and fertilizers dose varies depending upon soil type, planting system. 60 kg N and 40 kg each of P and K per hectare. Half of nitrogen and whole of phosphorus and potash along with 15-20 tonnes of FYM are applied at the time of bed making. The remaining of nitrogen is applied in two split dozes, 20 and 40 days after sowing.

Irrigation

It requires frequent but light irrigation, especially in the early stages of crop growth. First two to three irrigations are given at short intervals of 2-3 days with full care so that there is no overflow of water over the sown seeds before germination. Rest irrigations are given at 4 to 6 days interval as per the requirement. During summer season crop, subsequent irrigations are given at weekly intervals. For rainy season, irrigation may not be required between July and September if the rains are well distributed. Flowering and fruit setting are very critical stages for irrigation. Apply irrigation only through the furrows because sprinklers are detrimental to bee activity and induce foliar diseases.

Weed Management

Weeding is done mechanically by tilling especially in early stages of plant growth. Weeds from in-between plant spaces are removed manually. For chemical weed control, apply Fluchloralin @ 1.2 litres or Roundup @ 1.0 litre per hectare at least three days before sowing. Total weedicides like Gramaxone @ 0.75-1.0 litre per hectare is applied by providing shields (inverted cups etc) to the plants.

Pruning

Pruning is an important operation in cucurbits production not only for high quality fresh harvest but also for maximum quality seed production. A plant of bottle gourd bears so many branches but all of them are not able to bear fruits. So, it is essential to remove the branches from main stem for better flowering and fruiting. In cucumber, single stem should be kept up to 30 cm of plant height. The seed crop should be trailed to enhance the fruiting, seed yield and quality particularly in seed production of open pollinated variety.

Roguing

Seed crop is to be monitored at various stages of crop growth for removal of off-type and clearly should be carried out before flowering to avoid natural cross-pollination. The seed plot should be examined at three stages. The first inspection shall be made before the flowering in order to determine isolation, volunteer plant and other vegetative character like growth habit stem shape, leaf shape, size and colour. Second inspection shall be made during flowering and fruiting stage to check off types, sex expression, sex ratio and also based on flower and fruit character like shape, size and colour.

The Third inspection shall be made at mature fruit stage prior to harvesting in order to determine the true characteristics of fruits and it is essential to remove vine showing late maturity of fruits in variety of early maturity and so early maturing in late mature variety. At this stage fruit character will be very helpful in taking off types. The minimum permissible limits off type ine open pollinated varieties are given below:

Factor	Minimum permitted (%)	
	Foundation seeds	Certified seeds
Off types	0.10	0.20

Plant Protection - Insect and their Control

1. Red pumpkin beetle (*Raphidopalpa foveicollis*): Red pumpkin beetle is the most destructive insect pest that damages the young seedlings. Still, incidence and intensity of damage varies with crop to crop and cropping seasons. Spraying of solution of Carbaryl 50 WP @ 2 g or Fenvalerate 20 EC @ 0.75 ml per litre water has been found effective.

2. Bottle gourd bug: These greenish colour small insect damages the young plants of bottle gourd at 20-40 days stage of plant growth, by sucking leaf sap of apical tender leaves which leads to sieve like leaf appearance and badly affects the plant growth. The insect pest can be effectively controlled by spraying 2 ml Dimethoate or 1 ml imidachlopride per litre of water at 10 days' interval.

Diseases and their Control

1. Powdery mildew (*Erysiphe cichoracearum*): In the initial stages of powdery mildew, white powdery spots are formed on the upper surface of the leaves, which later spread on whole of leaves, stem and other plant parts. Badly affected leaves become brown and get shrinked. Spraying of Calixin or Karathane @ 1 ml per litre of water at 10 days interval effectively controls the disease. In bottle gourd spraying of Sulphex @ 2.5 g per litre of water has also been found effective.

2. Downy mildew (*Pseudoperonospora cubensis*): Downy mildew is a major problem in the areas having hot and high humid weather conditions. This fungus attacks only leaves. Yellow spots are seen on the upper surface of leaves and light purplish white spores appear on the lower surface. In advanced disease stage leaves dry. The disease affects all cucurbits. Spraying Blitox or Metalaxyl + Mancozeb @ 2.5 g per litre of water at 10 days' interval effectively controls the disease. Affected leaves should be removed from plants and buried. Crop rotation should also be adopted.

3. Anthracnose (*Colletotrichum orbiculare*): It is a seed-borne fungal disease of several cucurbits. First symptoms of the disease are seen on leaves in form of light coloured angular spots, which later turn black. The disease spreads fast and symptoms are seen on fruits and stems also. Plant dies if disease is not controlled. As a preventive measure treatment of seed with Bavistin 2.5 g per kg of seeds is useful. For controlling the disease Blitox or Dithane M-45 @ 3 g per litre of water or Bavistin @ 2 g per litre of water has been found effective.

4. Viral disease: Symptoms appears in early stage and plants affected appear bushy with rosette of leaves. Light green pale streak appears on the leaf. Uproot the virus affected plants and destroy. Spray Imidachloprid @ 0.25% at 15-20 days interval to control the vector.

Nerium: Drought Tolerant Flower Crop

Article ID: 40663

M. Velmurugan[1], P. R. Kamalkumaran[1], M. Anand[1]
[1]Tamil Nadu Agricultural University.

Nerium (*Nerium oleander* ; synonyms: *Nerium indicum, Nerium odorum*) belongs to the family *Apocynaceae* (Oleander family). Nerium is an evergreen shrub (or small tree) grows upto height of six meters. Leaves are long, pointed leaves and narrowly lanceolate and contains a prominent midrib which usually in groups of three. The flowers are tubular with five lobes, red or pink in the wild form and contain white, cream, yellow or purple cultivars. Flowers with double forms have also been reported and some are scented types. Fruit is composed of a pair of follicles that split along one side to release the seeds. The seeds are oblong, with a plume of hairs at one end. The plants are almost free from the incidence of pest and diseases and untouched by the cattle and goats due to their toxicity. The plants exudates sticky latex from the cut end of the stems. All parts of *N. oleander* contains toxic cardiac glycosides (oleandrin, digitoxigenin, neriin, folinerin, and rosagenin) that apparently exert a digitoxin-like effect (cardiotoxic potential) (Joubert, 1989 and Langford and Boor, 1996).

Nerium oleander is highly poisonous to humans, pets, livestock and birds. Ingestion causes nausea, vomiting, cardiac arrhythmias, hypotension (low blood pressure) and death. Its sap has been used as rat poison. The leaves also show insecticidal activity against sugarcane mite and citrus leaf miner. Oleandrin is used for treating cardiac conditions in patients who cannot tolerate digitalis. In traditional medicine, the leaves have been used for a variety of medicinal purposes, including the treatment of heart diseases, as a diuretic, antibacterial, and against snake-bite. The roots have been used externally in traditional medicine for treating cancer, ulcers and leprosy. Nerium is widely grown as an ornamental shrub or hedge and mainly planted in road dividers/medians/round abouts. It is drought tolerant and withstand heat and dust and grown with little quantity of water. In India, Nerium is distributed throughout the country but the commercial cultivation takes place only in Tamil Nadu.

In Tamil Nadu, Nerium is cultivated in Nilakottai, Trichy, Madurai and Salem districts. It is growing in an area of 1408 ha with a production of 33780 MT accounting to 24% of productivity. Flower opens in the early morning hours before the sun rise and hence the harvesting of flowers should be done during early morning hours *i.e.* before 5.30 a.m. (Parashuram *et al.,* 2019). Flowers of nerium is mainly used for making garlands and also used in Temples for worship.

Landscaping Uses

Nerium can be recommended to grow as a screen or a ledge and even as a border for lawn.

Varieties

Tall types: Single Rose, Single White, Single Red, Double types. Double types are quite handsome.
Dwarf types: Petite Salmon, Petite Pink.

Soil and Climate

Nerium can be commercially cultivated in tropical and subtropical conditions. It is a sun loving crop and it prefers warm humid climate for its successful growth. It can be grown in wide range of soils *viz.,* red lateritic or black or loamy soils with a pH range of 6.5 – 7.5. Adequate drainage is required for nerium cultivation.

Propagation

It is vegetative propagated ornamental plant. Hard or semi hard woodcuttings of 60 cm length are used for commercial planting.

Micropropagation

The micropropagated plantlets can be developed using green immature pods as the explants source (Soundararajan and Karrunakaran, 2010).

Planting

Rooted cuttings can be planted during the onset of rainy season *i.e.,* June to July. The field is ploughed 3 to 4 times and bring to a fine tilth. Before planting pits of 30 cm x 30 cm x 30 cm pits dugged at 2 x 2 m spacing and filled with equal proportion of FYM, red earth and top soil. At the time of planting, Biofertilizers *viz., Azospirillum* and *Phosphobacteria* (2 kg/ha each) has be mixed with 100 kg of FYM and applied to the pits. Irrigation is given immediately after planting and life irrigation on third day after planting.

Irrigation

The plants are irrigated as and when required *i.e,* once in 10 intervals depending on the weather conditions.

Nutrient Management

FYM @ 10 t/ha has to be applied during January and August month. NPK 120:160:160 g/plant/year along with farmyard manure and biofertilizers reported to be improve growth and floral characters in one year old pruned plants (Gopitha *et al*. 2019).

Growth Regulation

Foliar application of GA_3 @ 150 ppm will act as growth promoter (Vijai Ananth and Ramesh Kumar, 2012). Gibberellic acid has influence on cell division and cell elongation and enhanced the vegetative growth. Alar, the growth retardant inhibited biochemical processes resulting in less spreading of plants. Also, Paclobutrazol @ 100 ppm will suppress the plant height and delay flowering. Paclobutrazol modify the plant architecture by inducing dwarfness with improved flower quality and yield (Rajiv *et al*., 2018).

Micronutrient Application

The combination of $FeSO_4$ @ 0.75%+$ZnSO_4$ @ 0.50% as foliar spray promotes early flowering and increase the flower bud weight and flower yield (Kumar and Haripriya, 2010).

Pruning

Pruning is done to remove the dead or overgrown branches or stems, especially to encourage growth. Pruning during December is advisable to get high yield and to keep the bushes under manageable size. The following pruning schedule can be followed for commercial cultivation.

1st year- remove one third of old mature stems near ground level.
2nd year- remove one half of the remaining old stems and cut back long new shoots.
3rd year- remove remaining old stems and cut back long new shoots.

Plant Protection

Leaf eating caterpillar: Spray Imidachlorprid 2 ml/lit or Emamectin benzoate 2 ml/lit to control the pests.

Harvesting and yield: Flowering begins from the 4-6 months after planting. Plants flower throughout the year. Peak flowering occurs between April to August. However, flower yield is low during rainy and winter season. Harvesting is done during the late evening or between mid-night and early morning hours to avoid bud opening. The flowers buds are packed in tight polythene bags to avoid flower opening and immediately transported to market. The approximate yield of 100 - 125 kg of flowers/ha/day can be obtained.

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Role of Protein and DHA in Brain Boosting During Pregnancy and Lactation

Article ID: 40664

Ramyashree, S. R.[1]
[1]Dept. Food Science and Nutrition, UAS, GKVK, Bangalore.

Introduction

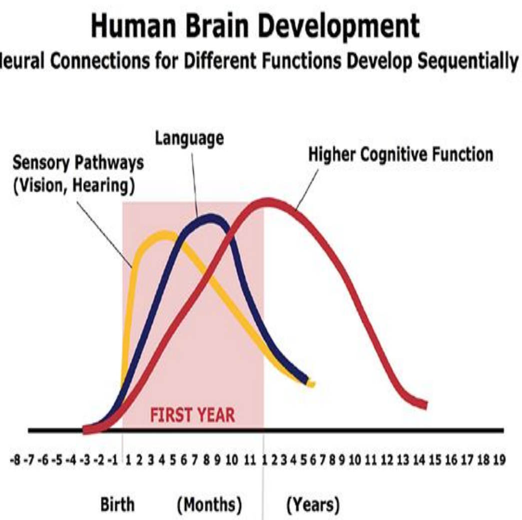
Brain is one of the most important organs in the body and it requires a high level of nutrition to function optimally. Glucose utilization is 60% of the total in the body. During development, proper maternal and infant nutrition are needed to ensure that the neural substrates are lying down with integrity and this period is known as a sensitive period. That is, the organism is especially sensitive to a deficiency of a specific nutrient at a specific time. If the deficiency is severe, the issues can be devastating and irreversible.

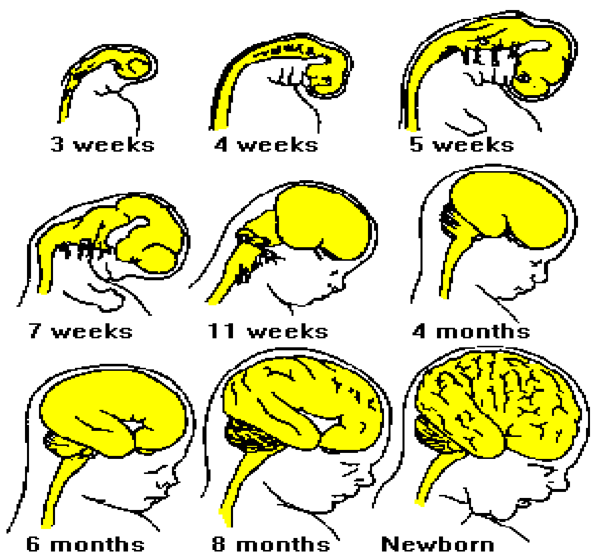
Importance of Maternal Nutrition before Conception

In the first few weeks of gestation when most women do not know that they are pregnant, the zygote is growing at an incredible rate. Proper nutrition supports the rapid cell division, development of supporting structures such as the placenta, implantation, and neural tube closure that occur in those first few weeks. Therefore, it is important for women of child-bearing age to have the proper nutrients on board in the event of unanticipated pregnancy.

Nutrients which Play Important Role During Pregnancy

1. Docosahexaenoic acid (DHA).
2. Protein.





Different stages of brain development

Protein

Protein is one of the most important nutrients. Pregnant and breastfeeding women need to consume almost 50 per cent additional protein to support foetal growth and expansion of maternal tissues. As per the latest Indian Council of Medical Research recommendations, 55gm protein per day must be taken by a sedentary woman whereas the need in a pregnant and breastfeeding woman is quite higher. It is about 82 gm during pregnancy and 79 gm for breastfeeding. Protein is necessary for healthy growth and development of the foetus, and also for accretion in maternal tissues. Proteins help to build and maintain tissue and muscle mass. It is also essential for extra blood production and promotes healthy weight gain during pregnancy. During pregnancy, changes in reproductive hormones and immune systems during pregnancy collectively make them more susceptible to certain infections uboptimal maternal nutrition during pregnancy may result in Intra Uterine Growth Restriction and higher chance of Low Birth Weight and Small-for-Gestational-Age babies.

Currently, it has been reported that close to 75 per cent pregnant and lactating women are not meeting their protein requirement. It is imperative that the diets of these women are evaluated, and they are given appropriate recommendations to meet the daily protein requirements.

Food sources: Meats & Poultry, Fish such as Salmon & Shrimp, Dairy such as Eggs, Milk, Legumes such as Beans, Lentils, Split Peas, Nuts & Seed such as Peanuts, Walnuts, Cashews Pistachios, almonds and Whole grains.

Docosahexaenoic Acid (DHA)

1. Importance of DHA: the brain is 60% structural lipid and uses arachidonic acid (AA) and DHA for growth, function and structural integrity. It is the predominant structural fatty acid in the brain and retina and comprises approximately 40% of PUFA in our brain and 60% of the PUFA in retina.

2. Development of fetal brain: at birth, babies only 5% of adult weight yet brain is size is almost 70% of the adult brain. Brain growth continues by a further 15% during first year of life and in additional 10% during preschool years.

3. DHA Accretion in brain: There is a definite growth spurt in the human body during the last trimester of pregnancy and first postnatal months, with a large increase in the cerebral DHA content. DHA is only omega-3 fatty acid present in significant amounts in the brain.

Pregnancy and Nursing Benefits of DHA

1. During pregnancy, DHA supports optimal infant brain development, as well as in maternal wellbeing.
2. Developing infants cannot efficiently produce their own DHA and must obtain this vital nutrient through the placenta during pregnancy and from breast milk after birth.
3. It significantly enhances the level of DHA available to the fetus and infant may improve certain developmental outcomes, such as: eye-hand coordination, motor skills and attention span.
4. DHA supplementation in mother increases the mental performance of their children and also increases the duration of gestation & birth weight during pregnancy.

DHA and Postpartum Depression

1. Depletion of maternal DHA reverses during pregnancy and lactation has been suggested as one possible cause of postpartum depression.

2. It has been suggested that decreased omega-3 FA consumption correlates with increasing rates of depression.

3. DHA and birth weight: Neonatal DHA status is found to correlate positively birth weight.

4. DHA for maternal well-being: DHA supplementation during pregnancy can help to lengthen gestation and support the mental state of mother.

5. It enhances utero placental perfusion, oxygen delivery, vasodilation and thinning of blood in pregnant women and lactation and women reduces the risk of toxemia.

6. Lack of DHA causes depression during pregnancy and lactation which has a negative impact on the development and health of new born.

7. DHA in infants: Essential for growth and functional development of the brain in infants.

8. Also required for maintenance of normal brain function through infancy, improves learning ability.

9. DHA deficiencies are associated with fetal alcohol syndrome, ADHT, cystic fibrosis, PKU, unipolar depression, aggressive hostility, and adrenoleukodystrophy.

10. Psychomotor development and intelligence: Breast fed infants of mother who were supplemented with DHA during 4 months of nursing had significantly improved psychomotor development at 2.5 years of age

11. Maternal and cognitive development: supplementation significantly enhances the mental health and cognitive development.

12. DHA and Mother's milk: Breast milk contains DHA. Pregnancy and fetus development depends on maternal sources of DHA from lipid stores, maternal diet and nutritional supplements.

13. Placenta selectively transports DHA from mother to fetus.

14. During 3rd trimester accretion of DHA in fetus liver, brain and retina at the rate of 1.59g/d.

Food sources: Walnuts, flaxseeds, almonds, hempseeds, fish, olive oil and green leafy vegetables.

Conclusion

Nutrition plays a vital role in building a healthy and normal baby. Hence the diet should contain these nutrients, apart from these other nutrients such as, Vitamin D, Folate, Iron, zinc, vitamin B12 and choline plays vital role in the pregnancy and lactation.

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Biophysical Basis of Plant Resistance to Insects

Article ID: 40665

Mamta Joshi[1]
[1]Department of Entomology, College of Agriculture, G. B. Pant University of Agriculture and Technology, Pantnagar, 263145 (Uttarakhand).

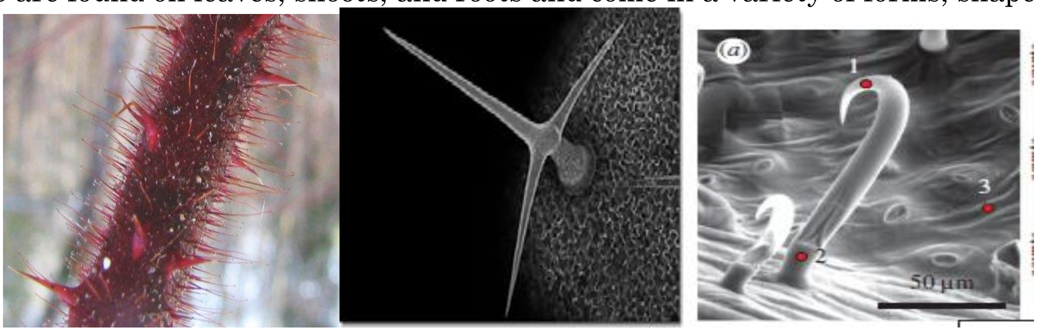
Introduction

Host plant resistance is an important component of Integrated Pest Management and one of the most effective methods for reducing insect damage. Each plant species has a distinct defense mechanism involving various morphological traits that have a significant impact on insect survival and reproduction.

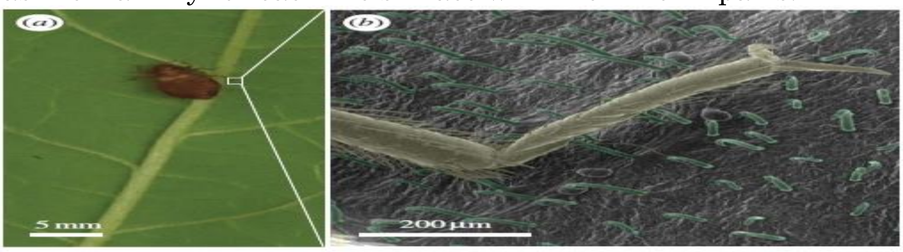
Biophysical Basis

Trichomes:

a. The epidermis of the plants bears cellular, hair-like outgrowths called trichomes or hair, according to the biophysical basis.
b. Pubescence refers to the trichome cover of a plant's surface.
c. These are found on leaves, shoots, and roots and come in a variety of forms, shapes, and sizes.



Non-glandular trichomes: Non-glandular trichomes affect insect locomotion, attachment, shelter, and oviposition, as well as their ability to reach the surface with their mouthparts.



Glandular trichomes: Glandular trichomes have the ability to produce, store, and secrete large amounts of various classes of secondary metabolites. The glandular trichome storage compartment is typically located on the tip of the hair.

Surface Waxes

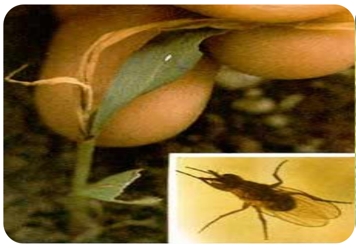
1. Epicuticular waxes function as phagostimulants or as feeding deterrents.
2. *Plutella xylostella*, a diamond back moth, is deterred from feeding on crucifer leaves by a wax bloom.


Thickness of Cell Wall

1. Toughness and thickness of various plant parts impair insect penetration of mouth parts for feeding and ovipositor for oviposition.
2. Rice varieties with thicker hypodermal layers are resistant to the stem borer *Chilo suppressalis*.
3. Sugarcane varieties with a very hard midrib in their leaves are resistant to *Scirpophaga nivella,* the sugarcane top borer.

Silica Content

In rice, high silica content interferes with feeding and boring of the larvae of the rice stem borer, *Chilo suppressalis*. Silica nanoparticles are a potential new insecticide for pest control.




Solidness and Other Stem Character

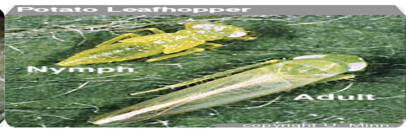
1. The insect-plant interaction was altered by the solid, hard, and woody plant stem.
2. Cucurbits' hard woody stems with closely packed vascular bundles resist feeding by the squash vine borer, *Melittia cucurbitae.*
3. Solid-stemmed wheat cultivars are resistant to the wheat stem sawfly, *Cephus cinctus.*

Anatomical Adoption of Organs

1. Plants' morphological structure varies slightly, which contributes to insect resistance.
2. Rice varieties with tightly wrapped leaf sheaths are less susceptible to the Asian stem borer, *Chilo suppressalis.*
3. Pink bollworm, *Pectinophora gossypiella*, and cabbage looper, *Trichoplusia ni*, are resistant to nectariless cotton varieties.

Plant Cuticle

1. Plant cuticle plays an important role in insect pest feeding and oviposition behaviour.
2. Younger citrus leaves are preferred by the bayberry whitefly, *Prarabemisia myricae,* for probing, oviposition, and survival over mature leaves.

Shape and Size

1. Plants with erect growth habits are preferred for oviposition by female budworm, Heliothis virescens, over plants with procumbent growth habits.
2. Pod damage caused by *H. armigera* has been found to be positively correlated with pod circumference, pod length, pod weight, and seed weight in chickpae.

Colour and Intensity of Light

Cotton varieties with red leaves are less susceptible to boll weevil, *Anthonomus grandis*, and budworm, *Heliothis armigera*.

Reference

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Industrial Uses of Cassava

Article ID: 40666

M. Velmurugan[1], M. Anand[1], P. R. Kamalkumaran[1]
[1]Tamil Nadu Agricultural University, Tapioca and Castor Research Institute, Yethapur, Salem.

Cassava (*Manihot esculenta Crantz.*) is one of the major tuber crop belongs to the family Euphorbiaceae. This is popularly known as tapioca, manioc, yucca and mandioca. This crop gives the third highest yielder of carbohydrates per cultivated area among crop plants, after sugarcane and sugar beets. India is the fifth largest producer of in cassava. Thailand is the world's largest exporter of cassava products. In India, Kerala and Tamil Nadu account for about 80% of the total acreage of the crop in India. In Tamil Nadu, Cassava is mainly cultivated in Salem, Namakkal, Erode, Cuddalore, Villupuram, Dharmapuri, Kallakurichi and Kanyakumari districts of Tamil Nadu (Velmurugan *et al*., 2018). Tapioca is considered as the cheapest source of Carbohydrates among the cereals, tubers and root crops and is a staple diet in many parts of Africa, South America and Asia. About 500 million people eat tapioca in the World. Nutritionally, it contains 98% Carbohydrates and appreciable amount of Calcium and Vitamin-C.

The sago industries are involved in the preparation starch, sago grains, vermicelli and chips. It has multifarious uses *viz.,* sago, dextrin, glucose, core binder, stabilizer, adhesives, sizing yarns, as thickener for printing clothes, *etc.,* It is the raw material base for an array of processed products. Realizing its potentiality as raw material, its cultivation has been extended to Tamil Nadu, Andra Pradesh, Karnataka and Orissa. Li *et al.* (2017) has stated the information's pertinent to the industrial uses of cassava with special emphasis on value addition through bio-refineries.

Post Harvest Handling

Normally fresh cassava tubers cannot be stored without spoilage within two days after harvest; because of rapid perishability of the tubers. The initial phase is the internal discolouration which spreads along the vascular system from wounds or burnishing and is followed by a complex of microbial rotting. The shelf-life of tubers can be increased by the following ways:

1. Surplus tubers are piled and watered daily to keep them fresh or coated with mud-paste to preserve them for 4-6 days.
2. Bunches of fresh undamaged tubers along with clump are arranged layer by layer with moist sand and also then covered with moist soil, which can give 80-85 % recovery and reduce 60-80% of HCN content.
3. Undamaged tubers can be stored in pits in layers, finally covered with soil medium, maintaining moisture content of 15-20 %.
4. Storage deterioration is mainly due to moulds and storage pests which should be controlled in time.

Food Applications

Tapioca is used in the preparation of flour, rava, macroni, papad, instant noodles, Noodles, Vermicelli and etc., Tapioca starch is a thickener and stabilizer in fruit pies, soups, puddings, breads, sauces, soy and meat products. It can withstand long cooking times without breaking down. And products made with tapioca don't lose their quality when frozen or reheated because tapioca retains its thickening capabilities throughout these processes. Tapioca becomes clear and gel-like when cooked and dissolves completely when used as a thickener.

Unmodified starch, modified starch and glucose are used in the food industry for one or more of the following purposes:

1. Directly as cooked starch food, custard and other forms;
2. Thickener using the paste properties of starch (soups, baby foods, sauces and gravies, etc.);
3. Filler contributing to the solid content of soups, pills and tablets and other pharmaceutical products, fee cream, etc.;
4. Binder, to consolidate the mass and prevent it from drying out during cooking (sausages and processed meats);

5. Stabilizer, owing to the high water-holding capacity of starch (e.g., in fee cream).

Confectionery

Native tapioca starch is used in confectionery for different purposes such as gelling, thickening, texture stabilizing, foam strengthening, crystal growth control, adhesion, film foaming and glazing.

Jellies and Gums

Low viscosity tapioca starches are widely used in gelled confectioneries. The most often used one is acid-thinned starch or enzymatically jet-cooked starch due to its high retrogradation and gel formation characteristics, which are enhanced by the presence of sugars. Powder starches are used as mould release agents when casting.

Beverages and Alcohol

Modified tapioca starch is used as a colloid stabilizer in the manufacture of beverages. Tapioca starch-based sweeteners are preferred in beverages for their improved processing characteristics and product enhancing properties. High dextrose equivalent syrups of tapioca-based hydrolysate are also excellent source for easily fermentable sugar for brewery applications.

Bakery Products

Although starch is the major constituent of flours, the art of' bread baking depends to a large extent on the selection of flour with the proper gluten characteristics. Starch is used in biscuit making, to increase volume and crispness. In Malaysia, cassava starch is used in sweetened and unsweetened biscuits and in cream sandwiches at the rate of 5-10 per cent. Tapioca starch imparts a golden-brown colour to the crust and permits longer conservation.

Canned Fruits, Jams and Preserves

Recent advances in these industries include the partial replacement of sucrose by dextrose or sulfur-dioxide-free glucose syrup. This helps to maintain the desired percentage of solids in the products without giving excessive sweetness, thereby emphasizing the natural flavour of the fruit.

Sago

Sago is a processed edible starch available in the form of small globules or flakes this is carried out by roasting and placing gelatinised granules on shallow aluminium pans and stirred continuously and then the granules are dried. The dried mass is passed through polisher. Yield of sago is 25% of the weight of fresh tuber. Sago contains 12% moisture and 87 % carbohydrate. Sago is mainly used for various food preparations *viz.,* infant foods, puddings, papada, payasam and uppma.

Wet flour ⟶ Roasting ⟶ Polishing ⟶ Sago granules

Tapioca Starch

Starches are basically carbohydrates, known as polysaccharides, *i.e.,* multiple molecules of sugar. For commercial use, they are derived from a variety of cereals like rice, wheat, sorghum, corn and tubers like potato, tapioca, sweet potato, etc. Internationally popular forms of starch are mostly derived from tapioca. Tapioca starch is often preferred over maize starch because of its easy availability, high viscosity, blend taste and easy degradation. Tapioca flour is obtained by the following process:

Washing ⟶ Peeling ⟶ Crushing ⟶ Flour

Monosodium Glutamate (MSG)

This product is used extensively in many parts of the world in powder or crystal form as a flavouring agent in foods such as meats, vegetables, sauces and gravies. Cassava starch and molasses are the major raw materials used in the manufacture of MSG.

Glucose Industry

At present tapioca glucose is usually produced as syrup or as a solid. The physical properties of the syrup vary with the dextrose equivalent (DE) and the method of manufacture. Graded glucose is mainly used as instant energy releaser and mostly preferred by sports persons.

Sweetener Industries

Tapioca starch accounts for about 80 percent of the raw material for sweetener products, such as glucose and fructose syrups. These products are used in the beverage industries as well as canned fruits, jams and others products.

Production of Commercial Caramel

Caramel as a colouring agent for food, confectionery and liquor is extensively made of glucose rather than sucrose because of its lower cost. If invert sugar, dextrose or glucose is heated alone, a material is formed that is used for flavouring purposes; but if heated in the presence of certain catalysts, the coloration is greatly heightened, and the darker brown products formed can be used to colour many foodstuffs and beverages.

Adhesive and Glue

Tapioca starches posses relatively high viscosity affords an appreciable binding capacity and becomes sticky when it is mixed with water or certain chemicals. It stays sticky over a very long period preferred for making industrial glues.

Plywood

Tapioca starch is applied for making glue which is an important raw material of the plywood industry. The strength and the quality of plywood depend largely on the quality of glue.

Conversion Industry

Tapioca starch is devoid of major contaminants found in cornstarch and sorghum starch. It is much better suited for hydrolysis and so is widely used by industries manufacturing downstream products like liquid glucose, sorbitol, maltodextrin, *etc.*

Pharmacy

Native starch is used as binders, fillers and disintegrating agents for tablet production.

Textiles

Tapioca starch is perfect for textile applications. This is widely used in the sizing of yarns and finishing of cotton and polyester fabrics. The starch has a important role in three stages of production of textiles *viz.,* mixing, printing and finishing. The tapioca starch is applied in different proportion to make the cloth glossy and permanent, for example 12% for cotton, 8% for rayon and 18% for synthetic cloth.

Paper

Tapioca starch remains in the finished paper, acting as an internal sizing agent to increase the paper strength. Apart from the above it is used in filler retention, paper coating (regular and colour) and preparation of and disposable diapers.

Alcohol

Ethanol is derived from tapioca starch and used as fuel. It accounted for 70% supplied to alcoholic beverage industry and lysol industry. One ton of tapioca starch yields 720 litres or 95% ethanol.

Corrugated Cardboard Manufacture

One of the large users of dextrins is the corrugated cardboard industry for the manufacture of cartons boxes and other packing materials. The layers of board are glued together with a suspension of raw starch in a solution of the gelatinized form. The board is pressed between hot rollers, which effects a gelatinization of the raw starch and results in a very strong bonding. Medium-quality flours are suitable for this purpose provided the pulp content is not too high.

Foundry

Starch is used as an adhesive for coating the sand grains and binding them together in making cores which are placed in moulds in the manufacture of castings for metals.

Well Drilling

Starches and modified starches mixed with clay are used to give the correct viscosity and water-holding capacity in bores for the exploratory drilling of oil wells or water wells. These starch products are replacing other commercial products for making the muddy materials which are indispensable for drilling wells. For this purpose, a coldwater soluble pre-gelatinized starch which can be made up to a paste of the required concentration on the spot is desired.

Cosmetic Industry

Tapioca starch is used as dusting powder for make-up, soap filler/extender for the preparation of face creams.

Explosives Industry

Tapioca starch is used as wide range binding agent and match-head binder in explosives industry.

Construction Industry

In the construction industry is used as concrete block binder, plywood/chipboard adhesive, gypsum board binder, asbestos, clay/limestone binder, erecting fire-resistant wallboards and paint filler.

Mining Industry

Tapioca starch is used for ore flotation, ore sedimentation and oil well drilling muds.

Other Uses

1. In metal industries tapioca starch is used in foundry core binder, sintered metal additive and sand casting binder.
2. In addition to the above, tapioca starch helps in the preparation of biodegradable plastic film, dry cell batteries, printed circuit boards and leather finishing.

Animal Feed

1. Starch is highly economical and therefore extensively used as a filler in the manufacturing of compounded animal feeds.
2. Semi-dried leaves of tapioca can be used as safe animal food.
3. After harvesting, under sized tubers after grading can be chopped and can be preserved for six months. The cyanide content is reduced up to 80% and can be used for animal food including piggery

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Report on the Phytoplasma infecting Chickpea (*Cicer arietinum* L.) in Tamil Nadu

Article ID: 40667

T. K. S. Latha[1], P. Indira Gandhi[2], M. Paramasivan[1]
[1]Associate Professors (Plant Pathology), [2]Associate Professors (Agricultural Entomology),
Tamil Nadu Agricultural University, Regional Research Station, Vridhachalam – 606 001, Tamil Nadu.

Introduction

Chickpea (*Cicer arietinum* L.), crops belong to the family fabaceae is one of the important pulse crops, accounting to the total share of 50% of the total pulse. It contains a rich source of protein and is consumed as dal by people worldwide. The crop loss due to biotic and abiotic stress has been reported for several years. Among the biotic factors, the crop is infected by several fungal and bacterial diseases, including dry root rot, *Fusarium* wilt, *Colletotrichum* stem blight and *Botrytis* grey mold. In addition, phytoplasma disease expressing symptoms of bushy appearance, reduced leaf size and reddening were found to be an emerging disease of chickpea in Tamil Nadu. Venkataraman (1959) reported the phyllody of chickpea for the first time in Tamil Nadu as a phytoplasma disease based on symptomatology. However, the occurrence and characterization of phytoplasmas in chickpea notably has not been adequately reported in Tamil Nadu. The phytoplasma disease is transmitted through leaf hopper under field conditions as well as side wedge grafting under experimental plots.

Figure 1. Symptoms of phytoplasma on chickpea with stunting and bushy appearance of infected plants (a) and healthy plants (b) under field cultivation.

Material and Methods

The survey was conducted in chickpea growing areas of Coimbatore, Dharapuram, Pollachi, Udumalpet and experimental plots of Pulse Department, TNAU, Coimbatore during the year 2018-2019. The DNA was isolated from infected chickpea samples using the modified CTAB method to detect phytoplasma as per the protocol described by Warokka *et al.* (2006).

The specificity in amplifying the 16S rRNA gene of phytoplasma in nested PCR method was used to detect the phytoplasma present in disease-infected chickpea samples. The amplified PCR products were submitted for sequencing. The resulted sequences were edited using BIOEDIT software to obtain full length sequence of 16S rRNA of phytoplasma. The nucleotide sequences were searched for sequence homology using BLAST search against Genbank database (http://www.ncbi.nih.gov/BLAST). The related phytoplasma 16S rRNA gene sequences retrieved from the GenBank database were used for phylogenetic analysis. The phylogenetic tree was constructed with bootstrap for 1000 times using the neighbor-joining method and compared.

Results and Discussion

The association of Phytoplasma in chickpea was confirmed through symptomatology and molecular assay using nested PCR analysis. The infected chickpea plants showing typical phytoplasma symptoms under field conditions were PCR amplified with a DNA fragment size of ~1.8 kb and ~1.2 kb from DNA extracted from infected plants but not from the DNA of healthy leaves collected and analysed which confirmed the association of phytoplasma by specific amplification with an amplicon size of around 1.2 kb through nested PCR. (Fig 2). The PCR products were sequenced on both the orientations and the consensus sequences were deposited in GenBank (Accession No. MW715055).

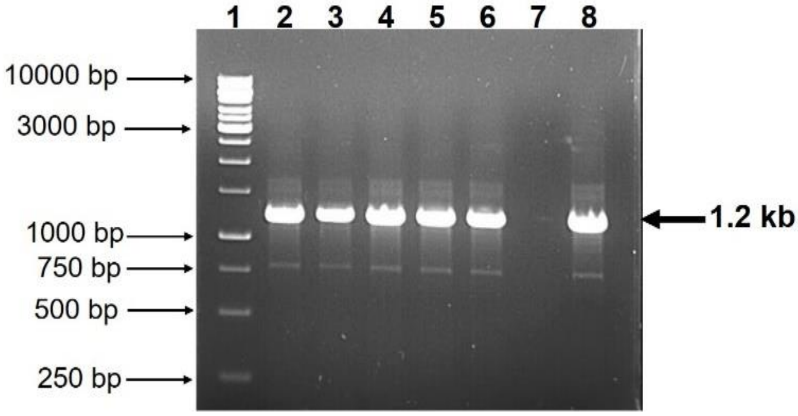

Figure 2. PCR amplification of 16S rRNA gene from phytoplasma naturally infected in chickpea. Lane 1 - 1 kb ladder; Lanes 2 to 6 - Amplified DNA fragment from infected samples; Lane 7- DNA from healthy sample; Lane - Positive control

The chickpea nucleotide sequence also had 99.10% identity among the sequences from three host crops *viz*., *Chrysanthemum morifolium*, *Tylophora indica* and bamboo (Accession Nos. MH547068; KY612250 and KF773149), especially with 16S rRNA gene sequences of 16SrI (*Candidatus Phytoplasma aurantifolia*) phytoplasmas infecting bamboo and chickpea from India. The BLSAT analysis showed 99% similarity with 16SrII group belongs to *Candidatus Phytoplasma aurantifolia*.

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Biofortified Millets: Sustainable Approach for Mitigating Malnutrition

Article ID: 40668

Suvarna Nagrale[1], Nandan Tayade[2]
[1]Ph.D. Scholar, Department of Agril. Botany, PGI, Dr. PDKV Akola (M.S.).
[2]ICAR-National Bureau of Plant Genetic Resources, RS, Akola (M.S).

Summary

Nutritional insecurity is becoming a major threat to the world's population that is highly dependent on cereals-based diet, deficient in micronutrients. More than three billion people around the world can't afford a diet of nourishing, diverse foods that provide enough essential vitamins and minerals (micronutrients). Hidden hunger leads to high rates of stunting, blindness, anaemia, poor pregnancy outcomes, and developmental impairments in children. Half a billion women suffer from anaemia due to iron deficiency. This condition negatively affects their reproductive health of women's. Hidden hunger weakens immune systems, leaving people vulnerable to infections such as diarrhoea and health threats such as COVID-19 Therefore, to overcome the malnutrition in human beings, improvement of crop quality by using bio-fortification process for important crop plants through various advance breeding and agronomic strategy that is sustainable solution. Target crops for increase micronutrient status like wheat, pearl millet, sorghum, small millets for Zn and Fe. Biofortification in millets crops is an sustainable way to mitigate micronutrient malnutrition.

Introduction

Biofortification is a Greek word "bios" means life and Latin word "fortificare" means make strong. Biofortification is a food-based approach to overcome the nutrient starvation. Millets are nutritionally superior as their grains contain high number of proteins, essential amino acids, minerals, and vitamins. Nutritional insecurity is a major threat to the world's population that is highly dependent on cereals-based diet, deficient in micronutrients. Next to cereals, millets are the important sources of energy in the semi-arid tropics and drought-prone regions of Asia and Africa. Millets provide 75% of total calorie intake next to cereal grains with an average annual production of 14.2 and 12.4 million tons (Belton and Taylor, 2004). India is the leading producer of millets accounting for about 80% of the global millet production.

Potential Source of Nutrition

Millets are commonly called as "small seeded grasses" which include Pearl Millet, Finger millet, Foxtail millet, Proso millet, Barn yard millet, Kodo millet and little millet. Among the millets, pearl Millet to occupies 95% of the production. More than 80% of millet grains are used as a food, while the rest is used as animal fodder and in brewing industry for making alcoholic products. The grains are ground into flour and consumed as cakes or porridges. Millets are recommended for well-being of infants, lactating mothers, elderly, and convalescents. Millet grains is considered "gluten-free" because grains release sugar slowly into the blood stream. With high fiber and protein content, millets are preferred as dietary foods for people with diabetes and cardiovascular disease.

Pearl millet is rich in Fe, Zn, and lysine (17–65 mg/g of protein) compared to other millets (Hadimani et al.,2001). Foxtail millet contains a high amount of protein (11%) and fat (4%). The protein fractions are represented by albumins and globulins (13%), prolamins (39.4%), and glutelins (9.9%). It is thus recommended as an ideal food for diabetics. It also contains highest amounts of antioxidants i.e phenols, phenolic acids and carotenoids (Saleh et al., 2013). Finger millet grains contain significant amount of minerals like Ca, Mg, and K (Devi et al., 2014). Positive calcium content maintains healthy bones, while potassium prevents the onset of diabetes, renal and cardiovascular diseases. It also has high levels of amino acids like methionine, lysine and tryptophan (Bhatt et al., 2011), and polyphenols (Devi et al., 2014). Proso millet contains the highest number of proteins (12.5%) while barnyard milletis the richest source of crude fiber (13.6%) and Fe (186mg/kg dry matter) (Saleh et al., 2013). Barnyard millet grains have own other important functional constituents viz. g-amino butyric acid (GABA) and b-glucan, used as antioxidants and it also help to reducing blood lipid levels. Among the millets, barnyard millet content lowest carbohydrate, hence is recommended as an ideal food for type II diabetics.

NUTRITIONAL CONTENT IN MILLETS

Millet	Iron (in mg)	Calcium (in mg)	Minerals (in g)	Fibre (in g)	Protein (in g)
Pearl millet	16.9	38	2.3	1.3	10.6
Finger millet	3.9	344	2.7	3.6	7.3
Foxtail millet	2.8	31	3.3	8.0	12.3
Proso millet	0.8	14	1.9	2.2	12.5
Kodo millet	0.5	27	2.6	9	8.3
Little millet	9.3	17	1.5	7.6	7.7
Barnyard millet	15.2	11	4.4	10.1	11.2

Source: Millet Network of India

Figure 2. PCR amplification of 16S rRNA gene from phytoplasma naturally infected in chickpea. Lane 1 - 1 kb ladder; Lanes 2 to 6 - Amplified DNA fragment from infected samples; Lane 7- DNA from healthy sample; Lane - Positive control

Approaches for Biofortification

Biofortification is a method that involves the use of various plant breeding approaches or agronomic practices to enhance the density of essential nutrients in the edible part of staple food crops.

Agronomic biofortification is a fertilizer-based approach that relies on soil and foliar application of micronutrients either alone or in combination with other fertilizers. A Zn fertilizer strategy is an effective way to biofortify cereal crops with Zn. In sorghum combined application of 30 kg S ha^{-1} through gypsum, 0.5 kg^{-1} B ha through borax and 10 kg Zn^{-1} ha through zinc sulphate it helps to Increase in Zn concentration in grain by 7 mg kg^{-1} grain by (Sahrawat et al 2008). In finger millet Foliar sprays of 0.2% ZnSO4 and Zn-EDTA twice at 30 and 60 days after sowing Increase in total Zn and Fe uptake (Kumar et al., 2020).

Genetic biofortification is a strategy to produce with higher micronutrient levels (nutritional quality) and reducing levels of anti-nutrients of staple food crops using various plant breeding techniques. In pearl millets, the hybrids HHB-299 (73.0 ppm Fe & 41.0 ppm Zn) and AHB 1200 (77 ppm Fe & 39 ppm Zn) showing highest concentration of Fe & Zn (Satyavathi et al., 2021). In finger millet CFMV-1 (Indravati) (58 ppm Fe & 44 ppm Zn) and CFMV-2 (25 ppm Zn & 39 ppm Fe) and little millet CLMV-1 (59 ppm Fe & 35 ppm Zn) recorded highest amount of Fe & Zn by (Yadava et al., 2020).

Needs of Biofortification in Millets

Cereals being a staple food in Indian diet with cost effective and single largest source of energy reaching to every person via daily diet. Cereal grains are considered as potential source of micronutrients for mitigating malnutrition due to their highest consumption and availability per person. Millet crops are treated as nutri-cereals considering their nutritional status and will be another potential group suitable for biofortification (Yamunarani et al., 2016). Millets offer abundant micronutrients like vitamins, beta carotene, which are being consumed like pharmaceutical pills in present day. In the current situation, all the millets are extraordinarily superior and are therefore, the solution for the malnutrition and obesity that affects a vast majority of the Indian population.

Conclusion

Millets are highly nutritious crops feeding poor populations. biofortification most economical approach for overcoming hidden hunger. Highly nutritious millet crops to fight against the micronutrient malnutrition with good grain qualities and significant amounts of essential amino acids, minerals, and vitamins.

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Green Manuring: A Sustainable Approach for Soil Health Improvement

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Abhik Patra[1], R. P. Singh[1], M. S. Kundu[2], Gagan Kumar[1], Pankaj Malkani[1], Bhushan Kumar Singh[1], Sourav Choudhury[3], Arnab Kundu[4], Sayon Mukherjee[5]

[1]Krishi Vigyan Kendra, Narkatiaganj, West Champaran–845455, Bihar, India.
[2]Directorate of Extension Education, Dr. Rajendra Prasad Central Agricultural University, Pusa–848125, Bihar, India.
[3]Krishi Vigyan Kendra, Sukhet, Madhubani– 847404, Bihar, India.
[4]Krishi Vigyan Kendra, Lada, Samastipur– 848209, Bihar, India.
[5]Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi–221005, Uttar Pradesh, India.

Introduction

Green manuring and sustainable agriculture go hand in hand in order to maintain long-term productivity and environmental health. Green manuring is a form of sustainable agriculture that focuses on the use of organic matter to improve soil fertility and crop yields. It is an ancient practice that has been employed by farmers since the earliest days of agriculture. By incorporating organic material into the soil, green manuring can help sustain soil fertility, improve water retention, and reduce the need for chemical fertilizers. Sustainability in agriculture is a broad concept that encompasses a range of practices, from organic and conservation-minded farming to the use of renewable resources and the reduction of environmental impacts. Sustainable agriculture seeks to produce food in a way that is ecologically sound, economically viable, and socially responsible. Green manuring is an important component of a sustainable agricultural system. By incorporating organic matter into the soil, green manuring can help improve soil fertility, water retention, and reduce the need for chemical fertilizers. Not only does green manuring help maintain soil fertility, but it also helps reduce soil erosion and can reduce the impacts of climate change. Additionally, green manuring can improve the availability of nutrients in the soil, resulting in increased yields and improved crop quality.

Green manuring can be defined as a practice of ploughing or turning into the soil, undercomposed fresh green plant tissue for the purpose of improving fertility status, physical and biological condition of the soil. Green manuring can be done in a variety of ways, such as planting a cover crop, incorporating crop residue, or growing particular type of short duration crops and mowing down them into the soil. Cover crops are a type of green manure, as they are planted between crops to prevent erosion and to add organic matter to the soil. Cover crops can be annuals (planted and tilled in after one growing season), biennials (planted and tilled in after two growing seasons), or perennials (left in the soil and managed over multiple years). Cover crops can also be planted in the fall and tilled in the following spring. More specifically, crop residues refer to the leftovers from harvested crops. These residues can be left on the surface of the soil or incorporated into the soil. This type of green manuring helps return nutrients and organic matter to the soil and can also protect the soil from erosion.

Characteristics of Green Manuring Crops

Green manure crops are generally fast-growing, soil-improving plants that are planted, allowed to grow and then incorporated into the soil. Green manure crops are typically legumes, such as clover, alfalfa, beans, peas, and lupins. These crops can be used to increase soil fertility and improve soil structure [3,4]. Additionally, green manure crops can help to reduce soil erosion, reduce weeds, and improve water infiltration and retention (Fig 1). The characteristics of green manuring crops are listed point wise as below:

1. Green manuring crops are typically leguminous plants, such as sunhemp, dhaincha, clover, vetch, peas, lentils, soybeans, alfalfa, *etc.*
2. These plants are grown specifically for their ability to fix nitrogen from the atmosphere into the soil, which improves soil fertility and increases crop yields.

3. Green manuring crops are also effective at suppressing weeds, and can reduce the need for tillage and the use of chemical herbicides.
4. Green manuring crops can be grown as a cover crop, or mixed with other crops in a polyculture system.
5. Green manuring crops can be used as a source of mulch, and can provide a habitat for beneficial insects and other organisms.
6. Capable of establishing and growing quickly.
7. Tolerant to adverse climatic conditions such as drought, water logging, high and low temperatures *etc.* and tolerant to pests and diseases.
8. Easy to incorporate and quickly decomposable.

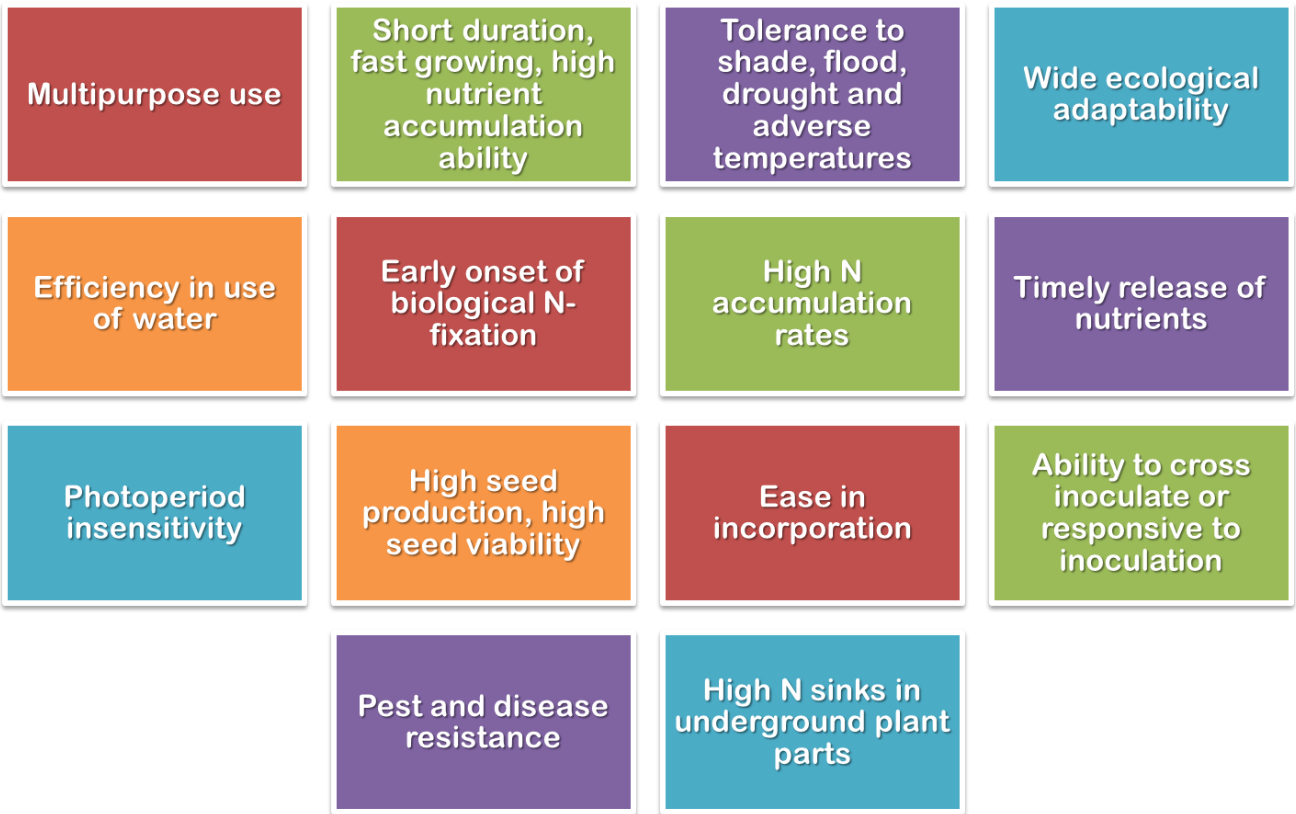

Fig 1. Desirable characteristics of green manuring crops

Benefit of Green Manuring

The main benefit of green manuring is that it improves soil fertility and quality. Green manure is full of nutrients such as nitrogen, phosphorus and potassium, which are essential for healthy soil and plants (Table 1). The organic matter in green manure helps to increase the amount of organic material in the soil, which improves the structure and fertility of the soil. This in turn helps to increase crop yields and improve the quality of produce [5]. Green manuring also helps to improve soil structure and drainage. The organic matter in green manure increases the amount of pore space in the soil, allowing for better aeration and drainage. This helps to reduce the risk of waterlogging and increases the availability of water and nutrients to plants. Green manuring also helps to reduce the need for chemical fertilizers. Chemical fertilizers can be expensive and can be harmful to the environment if used in excess. The benefit of green manuring are listed point wise as below:

1. Improves soil fertility: Green manuring helps to improve soil fertility by adding organic matter to the soil. This helps to improve the physical structure of the soil and increases its water-holding capacity. It also helps to promote the growth of beneficial microorganisms and earthworms in the soil.

2. Increases soil nutrient content: Green manuring helps to increase the nutrient content of the soil by adding essential nutrients like nitrogen, phosphorus, and potassium. These nutrients are essential for healthy plant growth and development.

3. Enhances soil structure: Green manuring helps to improve the structure of the soil by enhancing its tilth and porosity. This helps to increase the aeration, drainage, and water-holding capacity of the soil.

4. Improves soil moisture retention: Green manuring helps to improve the moisture retention capacity of the soil. This helps to reduce the need for frequent irrigation and ensures that the soil does not dry out.

5. Reduces soil erosion: Green manuring helps to reduce soil erosion by increasing the organic matter content of the soil. This helps to form a protective layer on the soil surface and prevents the loss of topsoil due to water and wind erosion.

6. Reduces weed growth: Green manuring helps to suppress weed population.

7. Increases water infiltration: Green manuring helps to increase the infiltration rate of water into the soil. This helps to reduce the runoff of excess water and prevents soil erosion.

8. Improves soil aggregation: Green manuring helps to improve the aggregation of soil particles. This helps to improve the soil structure and enhance its water-holding capacity.

9. Improves soil biological activity: Green manuring helps to improve the biological activity of the soil. This helps to promote the growth of beneficial microorganisms and earthworms in the soil.

10. Improves crop yields: Green manuring helps to improve crop yields by increasing the nutrient content and water-holding capacity of the soil.

11. Reduces the need for chemical fertilizers: Green manuring helps to reduce the need for chemical fertilizers as it helps to increase the nutrient content of the soil naturally.

12. Improves soil health: Green manuring helps to improve soil health by increasing the organic matter content of the soil. This helps to promote soil fertility and the growth of beneficial microorganisms in the soil.

13. Helps to reduce greenhouse gas emissions: Green manuring helps to reduce the emissions of greenhouse gases like carbon dioxide, methane, and nitrous oxide, as it helps to increase the carbon content of the soil.

14. Enhances carbon sequestration: Green manuring helps to enhance carbon sequestration by increasing the organic matter content of the soil. This helps to reduce atmospheric carbon dioxide concentrations.

15. Enhances crop diversity: Green manuring helps to enhance crop diversity by improving the fertility of the soil. This helps to promote the growth of a variety of crops.

16. Improves soil productivity: Green manuring helps to improve soil productivity by increasing the nutrient content and water-holding capacity of the soil.

17. Helps to reduce the need for synthetic fertilizers: Green manuring helps to reduce the need for synthetic fertilizers as it helps to increase the nutrient content of the soil naturally.

18. Increases soil microorganisms: Green manuring helps to increase the population of beneficial microorganisms in the soil. This helps to improve soil fertility and enhance crop yields.

Table 1. List of some green manuring crops contributing organic matter and nitrogen to the soil:

Local name	Botanical name	Growing season	Output in 45 – 60 days	
			Green matter (MT/ha)	Nitrogen contribution (kg/ha)
Sunhemp	*Crotolaria juncea*	Wet	21.2	91
Dhaincha	*Sesabania aculeata*	Wet	20.2	86
Green gram	*Vigna radiata*	Wet	8.0	42
Cowpea	*Vigna sinensis*	Wet	15.0	74
Guar	*Cyamopsis tetragonoloba*	Wet	20.0	68
Khesari	*Lathyrus sativus*	Dry	12.3	66
Berseem	*Trifolium alexandrium*	Dry	15.5	67

Conclusion

Green manuring is an important and essential form of organic farming and is the practice of growing and incorporating green manure crops into the soil to improve the fertility and physical structure of the soil. Green manuring is a way of adding nutrients to the soil and improving its fertility. It can be used to reduce the need for external fertilizers, increase soil organic matter content, improve soil structure, and reduce erosion. Green manuring involves the planting of specially selected cover crops, which are then plowed back into the soil. The cover crops are typically legumes, grasses, or other plants which are capable of fixing nitrogen from the atmosphere and adding it to the soil. The crop is grown for a short period of time and then plowed back into the soil, thus providing a source of organic matter and nutrients for the next crop.

Author Contributions

All authors contributed equally to the article and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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Biochemical Basis of Plant Resistance to Insects

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Mamta Joshi[1]
[1]Department of Entomology, College of Agriculture, G. B. Pant University of Agriculture and Technology, Pantnagar, 263145 (Uttarakhand).

"Resistance is the relative amount of heritable qualities possessed by the plant that influence the ultimate degree of damage done by the insect," according to the introduction.

Biochemical Foundation

Secondary metabolites: "Plants have evolved many specific, genetic controlled, enzymatically catalysed and complex compounds are called secondary metabolites".

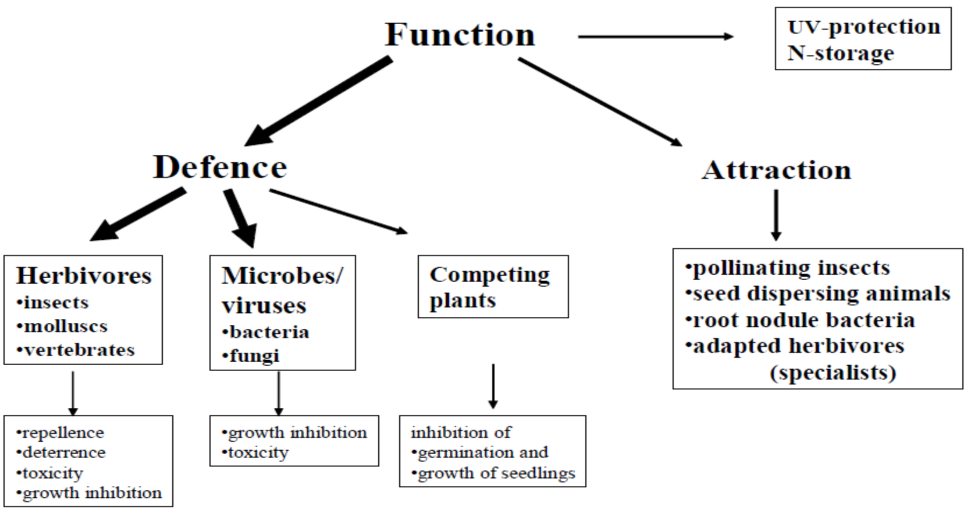
Insect attractants, repellents, feeding inhibitors, and toxins are all secondary plant metabolites.

Plant cells have created two methods for storing SM.

Vacuoles and plastids are intracytoplasmic.

Cell wall, pollen wall, and cuticular surface are examples of extracytoplasmic structures.

Plant secondary metabolites



Type of Secondary Metabolites

1. Nitrogenous Compound:

a. Alkaloids
b. Cyanogenic glucoside
c. Glucosinolates.

2. Terpenoids Compound:

a. Monoterpenes
b. Diterpenes
c. Triterpenes.

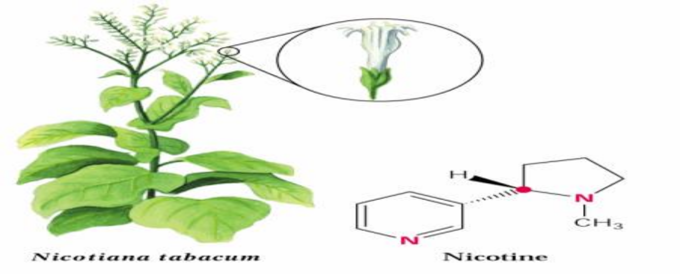
3. Phenolic Compound:

a. Flavonoids
b. Tannins
c. Lignans
d. Coumarins
e. Waxes.

Alkaloids

Compound containing nitrogen derived from various amino acids. Toxicity is the primary function. Inhibit or activate enzymes. Affect cell membrane and cytoskeletal structure. Block the ACh receptor present on the post synaptic membrane. Nicotine, Caffeine, Morphine, Colchicine, Ergolines, Strychnine, and quinine, among others.

Nicotine is the primary alkaloid found in all parts of the tobacco plant in varying amounts. Nicotine sulphate 40% alkaloid is extremely effective against homopterous insects, causing excitation, convulsion, paralysis, and death.



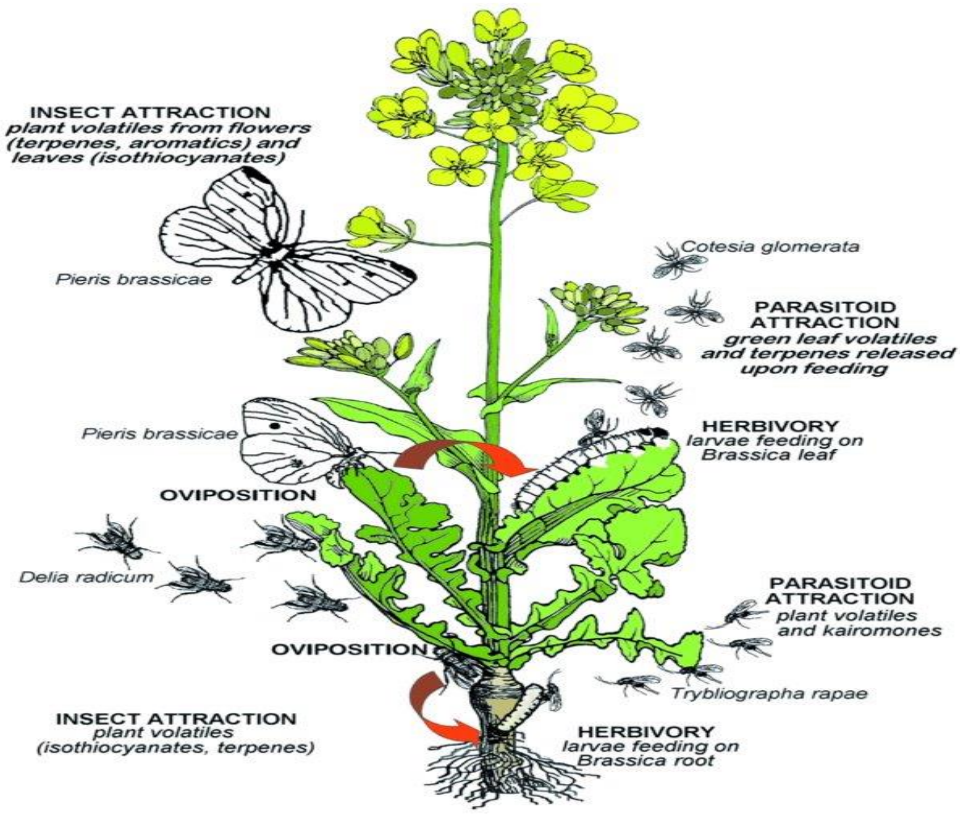
Cyanogenic Glycosides

These are typically carbohydrate derivates that are stored in inactive forms. When cell membranes are broken, these glycosides release "hydrogen cyanide," which inhibits cellular respiration. Cyanide, a plant defenses chemical released by adventitious roots of field grown sorghum, is a potential plant defenses chemical against a variety of insect pests.

Glucosinolates

They are sulphur and nitrogen-containing compounds that are abundant in crucifer plants. They are degraded in plants by thioglucosidase enzymes. These compounds interfere with insect host plant selection. Plant defence chemicals such as isothiocyanate, sinigrin, and gluconappin protect plants from aphids and grasshoppers.

Terpenoids



1. Organic chemicals
2. Over 10,000 known types of terpenoids
3. Affecting insect developmental rates, metamorphosis, fecundity and longevity.
4. Monoterpenoids are dominant components in the "volatile oils" such as citronella, limonene, menthol, camphor and pinene.
5. One of the best examples of monoterpence derivatives are "pyrethroids" found leaves and flowers of *Chrysanthemum spp.*
6. Pyrethroids are neurotoxins causing hyper excitation, uncoordinated movement and paralysis of insects.
7. Diterpenoids are widely distributed in latex and resins.
8. Resin diterpenes are key factor in resistance to bark beetles.
9. Clerodane inhibit the feeding of lepidopteron larvae.

Triterpenoids

1. Cucurbitacins (cucs) act as feeding deterrent for various insects.
2. Cucumber leaf beetles, Phyllotreta spp.
3. Spotted cucumber beetles, Diabortica spp.
4. Stem borer, Margonia spp.
5. Azadirachtin are most promising botanical insecticides against several insect pests.
6. They act as feeding deterrent but also cause larval mortality and interfare with normal growth and developments by disrupting moulting process.

Phenolics

1. Esters, methyl esters and glycosides are called phenolics.
2. Occur in waxes or on the external surfaces of plant organs.
3. Complex phenols (flavonoids) that give plants to their red, blue, yellow and white pigments.
4. Tannins and flavonoid molecules inhibit digestion by binding to plant proteins and making them more difficult for insects to digest.
5. Lignins are completely indigestible to insects and grind down insect mandibles.
6. Rotenone is the active principal flavonoid from the roots of *Derris elliptica* (Leguminosae).

Proteinase Inhibitors

1. Proteinase inhibitors (PIs) are plant defense proteins and are abundantly present in the storage organs such as seeds and tubers.
2. PIs are adversely affecting the protein digestion in the gut of insects.

This leads to deficiency of essential amino acids and exerts physiological stress on the insect, leading to growth retardation.

Absence or Insufficiency of Essential Nutrients

1. Essential nutrient deficiency or deficiency. The nutritional composition of plant tissue has a strong influence on the growth, development, reproduction, and survival of insects.
2. Rice cultivars low in asparagines reduce fecundity in the brown plant hopper*, Nilaparvata lugens.*

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CRISPR: A Way Towards Abiotic Stress Tolerance in Plants

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Ashita Patel[1], Axita Patel[2]
[1]Department of Genetics and Plant Breeding, NMCA, Navsari Agricultural University, Navsari-396450.
[2]Discipline of Biological Engineering, Indian Institute of Technology Gandhinagar, Palaj, Gandhinagar-382355.

Introduction

Sessile agricultural plants are vulnerable to a variety of abiotic stressors, which significantly reduce yields by an average of more than 50% and seriously adversely effect world crop output.

Abiotic stressors that negatively impact the environment have an impact on plant growth and increase the likelihood of low yield and subsequent economic loss. There have been numerous steps taken to address this problem. Currently, there is increased interest in using the CRISPR/Cas gene-editing technique to create plant variants that can withstand stress.

This user-friendly approach is well-liked by researchers due to its versatility. In the gene-editing procedure, the endonuclease "Cas" and the DNA sequence family "CRISPR" work under the control of a particular guide RNA. Various plant species had the CRISPR/Cas system applied to them.

Most of the time, Cas9 is used. There are numerous reports of CRISPR/Cas9 technology enhancing plants' ability to withstand abiotic stress. The effectiveness of the CRISPR/Cas9 system's genome editing depends on a number of variables, including Cas9 expression, RNA polymerase specificity, guide RNA expression, promoter sequence, and different kinds of transformation vectors. This system may occasionally need to be modified in order to provide the desired results.

The remainder of this study focuses on the use of CRISPR/Cas in coping with abiotic stress, covering topics like crop improvement and gene function discovery. We presented CRISPR technology and its derivative precision editing tools in this article.

Non-homologous end joining (NHEJ) repairment pathway, which can inactivate particular genes, is primarily responsible for gene function identification. Crop improvement is accomplished by selecting mutant plant genomes based on a wealth of gene bank data, and then endowing the crops with abiotic stress resistance. We demonstrate a variety of CRISPR editing platforms for abiotic stress resistance studies and their molecular mechanisms that enhance crops, outline the limitations of these genome editing technologies in plant applications, and give a few research trends in line with the latest developments.

The only known adaptive immune system in prokaryotes is CRISPR-Cas. Small guide RNAs (crRNAs) are used in this technique to interfere with invasive nucleic acids in a sequence-specific manner. The genomic region that makes up CRISPR-Cas contains short repeated elements (repeats) that are separated from one another by distinctive sequences (spacers).

These spacers can come from mobile genetic elements (MGEs), such as bacteriophages, transposons, or plasmids. An AT-rich leader sequence precedes the so-called CRISPR array, which is often flanked by a group of cas genes that encode the Cas proteins. CRISPR-Cas systems can now be broken down into two major classes, which are further divided into six kinds and a number of subtypes.Based on the presence of effector Cas proteins, which transmit immunity by cleaving foreign nucleic acids, the classification is made. Class 1 CRISPR-Cas systems (types I, III, and IV) use multiple effector proteins in their effector modules, whereas class 2 systems (types II, V, and VI) only use one as shown in figure 1.

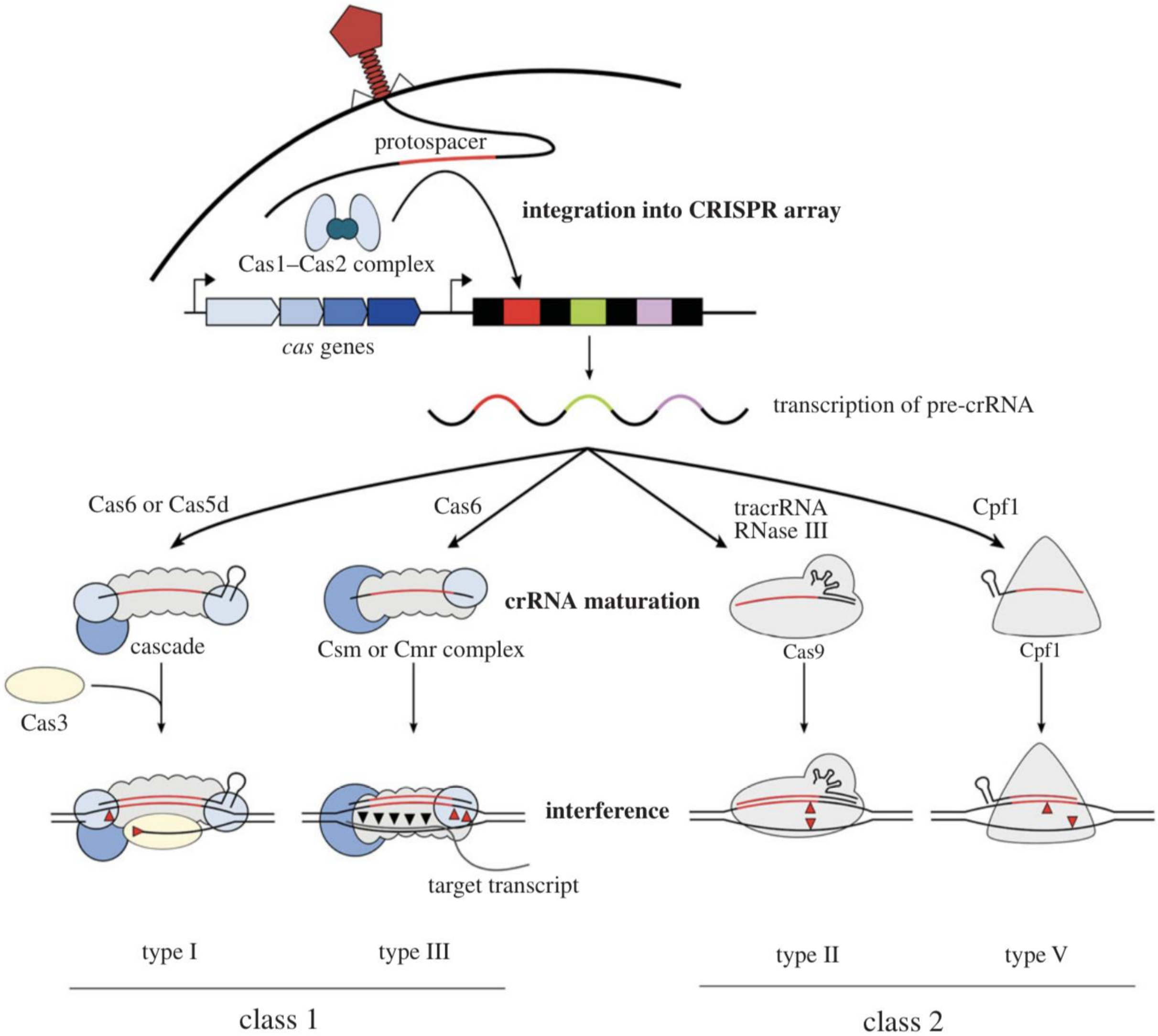

Figure 1: Simplified model of the immunity mechanisms of class 1 and class 2 CRISPR-Cas systems

Molecular Mechanisms: Adaptation, Maturation and Interference

The CRISPR-Cas system acts in a sequence-specific manner by recognizing and cleaving foreign DNA or RNA. The defence mechanism can be divided into three stages: (i) adaptation or spacer acquisition, (ii) crRNA biogenesis, and (iii) target interference.

1. Adaptation: A new spacer is produced in the first part of the process by incorporating a unique sequence of the invading MGE called a protospacer into the CRISPR array. This occurrence demonstrates the adaptive character of the host immune system and allows the host organism to memorise the genetic material of the invader [1]. Almost all CRISPR-Cas types contain two proteins, Cas1 and Cas2, which appear to be universally engaged in the spacer acquisition process. The type III-C, III-D, and IV CRISPR-Cas systems are exceptions because they lack homologous proteins. Additionally, type V-C exhibits a limited composition since it only includes a Cas1 homologue and the probable effector protein C2C3.

Significant progress has been made in recent years in understanding the pharmacological and genetic underpinnings of CRISPR-Cas immunity. However, there are still some gaps in our knowledge of the spacer acquisition mechanism [8,9]. In many CRISPR-Cas types, the method for choosing protospacers and processing them before integration is still mostly unknown. However, more recent discoveries provide insight into the biology of the spacer integration process. Escherichia coli's type I-E system Cas1 and Cas2 have been shown to form a complex that encourages the integration of additional spacers in a way that is similar to viral integrases and transposases. Despite the fact that Cas1 and Cas2 are both nucleases, Cas2's catalytically active region is not necessary for the acquisition of spacers.

At the leader-repeat border of the CRISPR array, a new spacer is typically added while the first repeat of the array is replicated.

The processes of the various CRISPR-Cas types might only be mostly preserved because different investigations have found differences in the needs and targets of the adaptation machinery. In the majority of type I CRISPR-Cas systems that have been investigated, Cas1 and Cas2 are adequate to promote spacer acquisition, whereas type I-B also needs Cas4 for adaptation [19]. Additionally, interference machinery is needed by Pseudomonas aeruginosa's type I-F CRISPR-Cas system to encourage the uptake of new spacers [20]. Similarly, type II-A systems require Csn2, Cas9 and tracrRNA (trans activating CRISPR RNA—see further details below) for acquisition.

A type III-B Cas1 protein that is coupled to a reverse transcriptase was found to have an additional, up to this point undiscovered, adaptation mode. Both DNA and RNA uptake were reported in this instance.

Target sequences that are integrated into the CRISPR locus are not chosen at random. A small sequence known as the protospacer adjacent motif (PAM), which is situated right next to the protospacer in type I, type II, and type V CRISPR-Cas systems, has been shown to be essential for acquisition and interference. The PAM-recognizing domain of Cas9 is in charge of choosing the protospacer in type II-A CRISPR-Cas systems.

After choosing a protospacer, Cas9 is thought to enlist Cas1, Cas2, and perhaps Csn2 to help the CRISPR array integrate the new spacer. Despite the lack of experimental proof, this trait may be shared by all class 2 CRISPR-Cas systems. Although it has been noted that the inclusion of the interference complex improves the frequency of integrated spacers that are close to a suitable PAM, the Cas1-Cas2 complex is sufficient for spacer selection and integration for type I-E. Additionally, several type I CRISPR-Cas systems' interference machinery can encourage the greater absorption of new spacers through a process known as priming when it binds to a protospacer that was chosen during an initial infection using crRNA guidance. As it absolutely requires an already-existing spacer matching the target, this process exhibits a different adaptation mode compared to naive spacer acquisition. Higher acquisition rates are typically obtained from protospacers that are close to the target site. Interestingly, primed spacer acquisition works for degraded target sites that would typically lead to poor interference and is independent of target cleavage. Although the precise process is still unknown, it has been shown that the interference complex can attract Cas1 and Cas2 during PAM-independent DNA binding.

2. Biogenesis: The CRISPR array is transcribed to create a lengthy precursor crRNA (pre-crRNA), which is then processed into mature guide crRNAs containing the memorised sequences of invaders. This procedure is done to enable immunity. Members of the Cas6 family carry out the processing phase in type I and type III systems, producing intermediate species of crRNAs that are flanked by a short 50 tag. The type I-C systems, which do not code for Cas6 proteins, serve as an exception. Here, pre-crRNA is converted by the protein Cas5d into intermediate crRNAs that have an 11 nt 50 tag. TracrRNA is necessary in type II systems for the processing of pre-crRNA. With each of the pre-repeats, crRNA's this RNA's anti-repeat sequence promotes the development of an RNA duplex, which Cas9 stabilises. The host RNase III then recognises the duplex and breaks it down, producing an intermediate form of crRNA that continues to mature through an unidentified mechanism to produce the mature short guide RNA.

The *Neisseria meningitidis* type II-C CRISPR-Cas system has an RNase III-independent mechanism. Each repeat in this instance contained a promoter sequence, some of which might start transcription and produce intermediate crRNA species. Despite the fact that crRNA:tracrRNA duplex processing by RNase III was found, it was not necessary for interference. It has been demonstrated that Cpf1 serves two purposes in the type V-A CRISPR-Cas system during CRISPR-Cas immunity. Following an additional maturation event of unknown type, Cpf1 processes premature crRNAs and uses the processed crRNAs it has produced to cleave target DNA.

3. Interference: Mature crRNAs are employed as guides to precisely interfere with the invasive nucleic acids in the last stage of immunity. In class 1 systems, Cascade-like complexes are used to induce target degradation, whereas in class 2 systems, target interference can be achieved with just one effector protein. Type I, II, and V systems particularly recognise the PAM sequence that is positioned either upstream (types I and V) or downstream (type II) of the protospacer in order to prevent self-targeting. In type III systems, the mature crRNA's 50 tag—which cannot base pair with the target to allow for complicated degradation—is used to distinguish between self and non-self.

Using crRNA as a guide, Cascade localises invasive DNA in type I systems and then enlists the nuclease Cas3 to degrade its target. Cas3 causes a nick to form on the foreign DNA before degrading the target DNA. In type II CRISPR-Cas systems, the effector protein Cas9 is guided to introduce a double-strand break in the target DNA by the tracrRNA:crRNA duplex. The type III systems' interference machinery is made up of the DNA and RNA-targeting Cas10-Csm (types III-A and III-D) and Cas10-Cmr (types III-B and III-C) complexes. It has been intriguingly demonstrated that the transcription of the target DNA affects the interference of type III-A and type III-B systems.

More specifically, in type III-A and type III-B CRISPR-Cas systems, the component Cas10 cuts DNA while Csm3 and Cmr4 cut transcribed mRNA. Type V CRISPR-Cas interference resembles type II interference in its behaviour. In type V-B systems, target cleavage is strictly necessary for an RNA duplex composed of tracrRNA and crRNA. However, Type V-A uses crRNA exclusively for target localization and degradation.

Abiotic Stress and Related Genes

Abiotic stresses to plants: Crop yields are suppressed by abiotic stresses. Plants have sophisticated stress tolerance systems as a result of experiencing abiotic challenges such as drought, salt stress, and cold stress. For instance, plants can swiftly reduce the quantity of reactive oxygen species (ROS) under stress to preserve the redox equilibrium in cells for survival. The molecular systems that carry out cellular control, including as signal perception and cascade transduction, transcriptional regulation, and adaptive metabolism, also play a role in plants' ability to tolerate abiotic stress. Plant tissue senescence is influenced by the growth stage, the environment outside, and internal signals. Abiotic stress tolerance is essentially a sophisticated quantitative polygenic characteristic, to put it simply.

However, there is a limit to how much stress plants can tolerate. The typical indications of necrosis in the plant will appear as a result of excessive and severe stress, including membrane leakage, cell lysis, and even cellular damage. In addition, although the heavy metal stress brought on by environmental deterioration won't always result in the death of plants within a particular range, it does result in the buildup of heavy metals in grains, endangering both human and animal health. As a result, scientists are still working to control plant genetic susceptibility to abiotic stress. There will be several options for target modification and resistance augmentation as molecular mechanism research develops.

Abiotic stress-related genes: Numerous regulatory and structural genes that are related to stress are present, and they are typically found as gene families. Using direct gene knockout to confirm gene function is a new and practical way for functional identification made possible by the development of CRISPR/Cas technology. Abiotic stress-related genetic variables can be divided into "Sensitivity genes" (S genes) with negative reactions and "Tolerance genes" (T genes) with positive regulatory responses. Through the use of OE (GmMYB118-overexpressing) and CRISPR techniques, GmMYB118 was discovered to enhance the drought resistance and salt tolerance of soybeans and Arabidopsis. The contribution of osmotic stress/ABA-activated protein kinase 1 (SAPK1) and SAPK2 to rice's salt tolerance was demonstrated using gene over-expression and CRISPR deletion. Reduced drought resistance and down-regulated drought-related genes were seen in tomato plants that had SlNPR1 knocked out using the CRISPR/Cas9 system, suggesting that SlNPR1 is regulated in response to drought. Sensitive genes are essential tools for crop genetic advancement. Several of these have been made public thanks to CRISPR-mediated gene knockdown. The auxin response factor SlARF4 (Auxin Response Factor 4) inhibits tomato salt tolerance and osmotic stress; the drought and salt tolerance gene OsDST controls indica rice's ability to withstand drought by influencing leaf width and stomata density. Abiotic stress-related genes are becoming crucial breeding resources. Through overexpression, uORF modification, CRISPR activation, or promoter element modification, T genes in plants can be enhanced. On the other hand, mutants with altered S genes can be produced by gene knockout.

The Positive Regulation Strategy of Abiotic Stress Resistance Tolerance Genes

It has been observed that transgenic or overexpression of abiotic stress-tolerance genes can improve plants' stress resistance. A quick and easy way to modify genes is provided by CRISPR technology, which has evolved into a potent tool for acquiring evolved lines.

CRISPR-Cas9-mediated uORF gene editing: By altering mRNA translation in plants and subsequently altering cellular protein levels, the phenotype of stress resistance can be modified. The modulation of the translation of pORFs related to oxidative stress can be accomplished by altering endogenous uORFs, which play a regulatory function in the translation of downstream primary ORFs (pORFs). The translation of genes that drive rice plant immunology can be controlled by inserting an uORF upstream of a pORF, which increases disease resistance without reducing yield.

uORF genome editing with CRISPR technology has shown to be a successful method for controlling mRNA translation and the rise in protein concentration that follows, ultimately leading to phenotypic change. By employing this technique, mutant lettuce plants with higher ascorbic acid content have been produced. Due to their higher antioxidant capacity, these plants are more resistant to paraquat than the wild variety. uORFs are extremely common in eukaryotes, making CRISPR-mediated uORFs targeted gene editing an efficient way to use T genes for enhancing stress resistance.

CRISPR-Cas9-mediated promoter engineering: The reconstituted engineered promoter module turns into a useful tool for controlling expression because natural promoters are constrained by their size and transcription efficiency. Synthetic promoter technology makes it possible to produce tailor-made promoters. Due to their improved genetic structure, chimeric or recombinant promoters operate better when used to express target genes.

The quantity of tomato seed compartments is regulated by quantitative trait loci. The potential for targeted editing of promoters to address abiotic stress resistance is enormous. It was predicted that the frequency of worldwide drought would rise by more than 20% by the end of this century. Because of the effects of continuous drought length, rainfall, and soil water storage capacity, the intensity of drought stress is unpredictable. To improve abiotic stress resistance in crops, untranslated region modifications can be used to encourage the transcription and expression of resistance genes. The overexpression of ARGOS8, a negative regulator of ethylene responses, has been shown to diminish ethylene sensitivity and increase grain yield in drought-stressed environments.

The Negative Regulation Strategy of Sensitive Genes

As was already established, mistakes in the DSBs-induced NHEJ repair mechanism can result in indels at double-strand break sites and impair the function of the target genes. Therefore, it is possible to specifically wipe out particular DNA targets using this repair route. Knocking down a gene by NHEJ is a quick and effective technique to give resistance to abiotic stressors.

NHEJ-mediated targeted gene knock-out: Numerous plants have been subjected to NHEJ-mediated knock-out, which is frequently employed to inactivate certain gene activities. As soil salinization and arable land availability worsen, it makes sense to grow crops that can withstand osmotic stress to make better use of places where fresh water supplies are scarce or the soil is already salinized. Wider leaves and decreased stomatal density in the mutants enhance the ability of leaves to retain water during dehydration stress. These germplasm resources are anticipated to be planted in regions with water scarcity or salinization. Breeding crops that can withstand osmotic stress is an easy technique to lessen the effect of osmotic stress on food security compared to the expensive process of improving the soil.

NHEJ-mediated genome targeted gene replacement: The HDR method, which is frequently used for gene knock-in, has a low efficiency that prevents its utilisation. The designed NHEJ-mediated knock-in platform has been demonstrated to be capable of achieving targeted knock-in in plants. To create glyphosate-resistant rice plants, Gao's team uses the NHEJ process to create gene replacement and insertions. A donor plasmid containing the fragment with the appropriate nucleotide changes was made. Pairs of sgRNAs targeting both intron locations close to the target exon were created. When both intron sites are simultaneously cut, the fragment that results contains the necessary modifications made by the donor plasmid to replace the genomic region in between the two intron sites via the NHEJ pathway. This method successfully achieved targeted gene insertion, replacing two amino acids in the conserved motif of the EPSPS enzyme and confer resistance to glyphosate in rice.

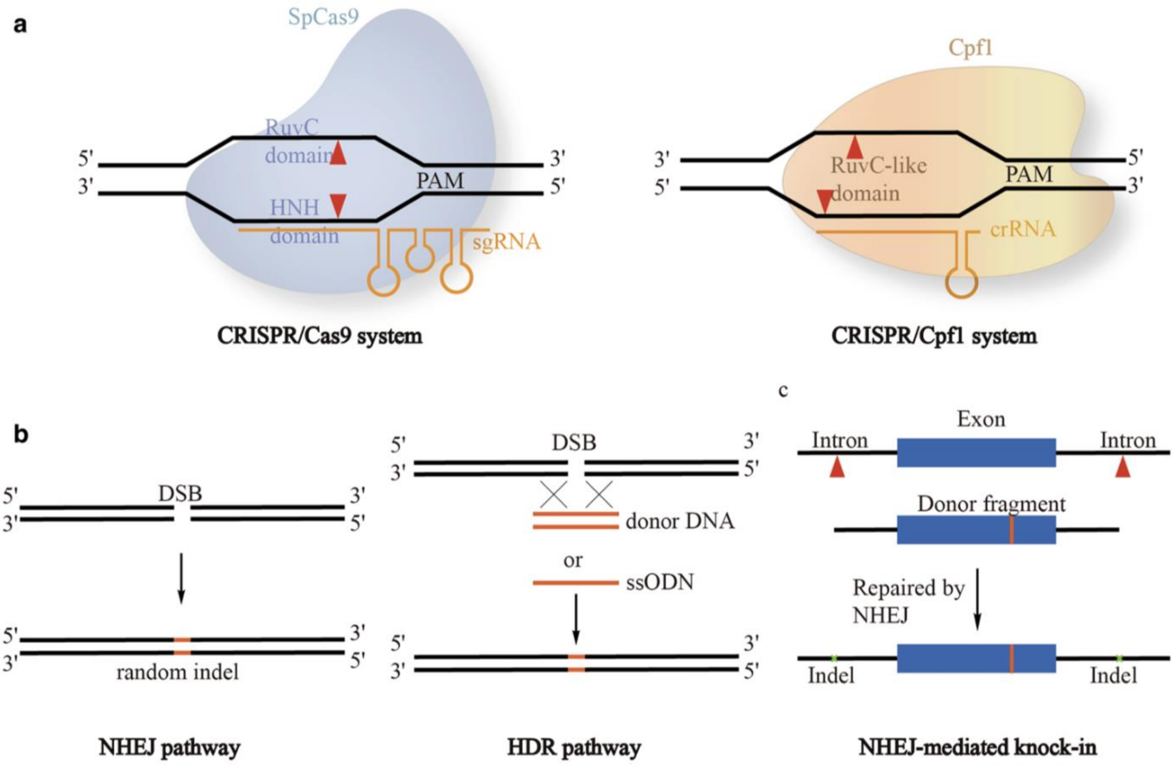

Figure 2: Two commonly used CRISPR system structure diagrams and schematic diagrams of gene editing

Figure 2: Explanation

1. Schematic diagram of CRISPR/Cas9 system and CRISPR/Cpf1 system. In CRISPR/Cas9 system, the assembly of the SpCas9, sgRNA and the target site upstream of 5′-NGG-3′ PAM into a complex is the first step of tar- geted cleavage. The RuvC and HNH catalytic domains in SpCas9 cleavage each of the target DNA double-strands respectively, lead- ing to DSBs formation. In CRISPR/Cpf1 system, the crRNA, Cpf1 and T-rich PAM form a complex, and the RuvC-like domain cleaves both DNA strands produce sticky ends.

2. Two DSBs repair pathways, the repair products by NHEJ pathway are random indels, and the repair products by HDR pathway are expected deletions, insertions, and DNA substitutions. Donor templates (double strand RNA, dou- ble strand DNA, single strand RNA or single strand DNA) harbor- ing homologous sequences with both sides of the DSBs are needed for HDR.

3. NHEJ-mediated knock-in or replacement after cleavage on two introns. After the NHEJ, the cleavage be eliminated and the original fragment is replaced by donor DNA fragment.

Base Editing-Conferred Abiotic Stress Resistance

Target-capacity AID's for crop improvement was demonstrated by its use for precision editing of rice ALS to confer herbicide resistance.

For the purpose of improving plants, BE3 has been used in conjunction with rAPOBEC1 as the cytidine deaminase. Wheat germplasm resistant to several herbicides has been created by precise editing mediated by BE3. Wheat can acquire resistance to nicosulfuron (a SU herbicide) by precise point mutations at ALS-P174. The platform can simultaneously edit the P174 and G631 sites of TaALS and successfully screened out double mutants resistant to both nicosulfuron and imazapic by using nicosulfuron tolerance as a co-editing marker. In addition, TaACCase-A1992 was the focus of this co-editing technique, which helped wheat become resistant to nicosulfuron and quizalofop.

To quickly and effectively find co-mutant lines, medium containing nicosulfuron can be used. This method is repeatable, and the preservation of ALS enzymes in various plants suggests that it has a broad variety of potential applications for developing novel types with dual herbicide resistance. Base editor has also been successful in altering the watermelon ALS gene to produce watermelons that are herbicide-resistant.

Only A•T to G•C and C•G to T•A conversions are possible for ABE and CBE, respectively. Scientists created STEME, a base editor with both CBE and ABE functions, to boost editing versatility and widen the target range.

STEME is made up of three components: nCas9, UGI, and a deaminase domain, which combines cytidine and adenosine deaminases. STEME is able to convert C to T, A to G, or both with the help of the fusion of two deaminases. The additional optimization of STEME-NG converts nCas9 to nCas9-NG and has a wider NG PAM range. It is noteworthy that STEME-NG can cause a wide range of mutations in plant cells, including C-to-T and A-to-G conversions as well as other replacements including C-to-G/A and G-to-C/T conversions and a minor amount of indel.

STEME-NG is a potent tool for directed evolution due to the variety of mutation types it contains. In fact, STEMEs were employed for the directed evolution of the rice OsACC and it was found that the mutations P1927F and W2125C give ACC inhibitory herbicide resistance. Sequencing revealed W2125S and I1879V resistance mutations, which were new resistance sites, in herbicide-resistant callus or plants that had been screened for resistance. This offers an innovative concept for finding fresh resistance sites at OsACC. At specific plant endogenous genome locations, this effective plant base editing system can cause A•T to G•C substitutions. Haloxyfop-R-methyl resistance was conferred by bringing out a cysteine to arginine point mutation at position 2186 of rice OsACC through PABE-7. The protospacer's positions 4 through 8 are the effective deamination window for this system.

Bottlenecks and Perspectives

The application potential of the many cutting-edge genome editing techniques presented in this article is still not fully realised due to a lack of efficient methods. For instance, current papers primarily used CRISPR/Cas9 gene knock-out technology to increase tolerance to salt stress, low temperature, and drought, but only a small number of studies took into account precision editing techniques. The complicated stress-related regulatory network of plants makes it difficult to reveal advantageous mutations or genes, which is one of the fundamental principles of precision editing for crop improvement. However, because it is a quantitative variable, phenotypic observation is more difficult, making it unable to directly screen for advantageous mutations on a wide scale.

As a result, it is challenging to efficiently filter evolutionary lines even when techniques for directed evolution have been established. CRISPR-based modifications to cis-regulatory sequences have a wide range of potential applications. Target gene regulation is made simple by the ongoing enrichment of custom promoters. The implementation of it is hindered by the mining of abiotic stress resistance genes. The intricate regulatory network in plants is still being studied, and while regulating certain genes artificially, it is important to take into account the other important genes that make up the regulatory network.

Even if the relevant genes are known, further research is still needed to determine the degree of regulation in order to achieve the necessary resistance. We already know that the control of one gene frequently results in altered levels of expression for a number of other genetic variables. We must thus investigate whether genetic alteration has any unintended consequences in addition to its intended effect of enhancing abiotic stress-resistance. Abiotic stress-related genes and transcription factors will likely undergo faster characterisation thanks to CRISPR-mediated knockout, which will also make it easier to understand how genes collaborate. Research on the genes involved in osmotic stress, low temperature, and other abiotic stress resistance is still in its infancy due to the regulation network's intricacy. Since abiotic stress tolerance is frequently a quantitative feature, simultaneous editing of several genes would surely improve breeding outcomes. Orthogonal Cas nucleases can only bind their corresponding sgRNA to independently edit various sites within the same cell. This is anticipated to be used in the breeding of crops resistant to abiotic stress. As genetic engineering and protein engineering advance, more chances will arise to advance the application of the CRISPR/Cas genome editing technology in agricultural abiotic stress resistance, which will aid in the detailed finding of plant resistance mechanisms.

Conclusion

Global climate change is predicted to pose a serious threat to agricultural profitability globally, posing a threat to food security as a result. Although they have tremendously aided in the development of superior crop varieties with improved resilience to abiotic stressors, transgene-based and molecular breeding technologies. However, these conventional techniques lack the ability to improve such qualities in the face of rising global population and climate change because of the complex inheritance and high G x E associated with these features. Nevertheless, genome editing may greatly help to lessen the impact of climate change on future farming scenarios, even if the impact of climate change on crop resistance is difficult to predict and is expected to vary depending on the crop and climate. The CRISPR-Cas technology has significantly changed crop breeding and paved the door for next generation breeding since it is straightforward, effective, highly precise, and multiplexable.

As of now, only a few number of studies have been completed and shown the CRISPR-Cas system's robustness and adaptability for abiotic stress tolerance in crop plants. However, these investigations provided evidence of this system's viability and efficacy for possible use in molecular breeding to enhance plant resistance to abiotic stress. Additionally, using naturally occurring elements like genes, promoters, Cis-regulatory components, and epigenetic alterations as a source for building novel regulatory elements may make it easier to tweak metabolic and regulatory pathways to modify crop plants' tolerance to abiotic stress. Therefore, the CRISPR-Cas system for targeted mutagenesis and genome editing hold enormous promise for producing elite cultivars of crop plants with improved and long-lasting climatic resilience. Since CRISPR-Cas will target tiny gene variations of complicated quantitative abiotic stress related features, it will be the future of crop breeding and the major strategy to end world hunger and sustain food security.

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Global Change Effects on Plant Chemical Defenses Against Insect Herbivores

Article ID: 40672

Mamta Joshi[1]

[1]Department of Entomology, College of Agriculture, G. B. Pant University of Agriculture and Technology, Pantnagar, 263145 (Uttarakhand).

Introduction

Climate change:

a. Any change in climate over time, whether caused by natural variability or by human activity" (IPCC, 2007).

b. Plant-insect interactions are critical in natural ecosystems because these two groups of organisms are extremely diverse, accounting for nearly half of all identified species on the planet.

c. Changes in abiotic environmental factors such as atmospheric CO_2 and ozone (O_3) levels, ultraviolet (UV) light, and temperature can all have a direct impact on the concentration of secondary chemicals in plants, which can then influence the rate of insect or pathogen attack.

Elevated CO_2 effects:

a. There is a general expectation that increased CO_2 levels will boost plant photosynthetic rates and growth.

b. Rising CO_2 levels in the atmosphere are also expected to have an impact on insect herbivore performance via changes in plant quality, such as variations in the levels of nutritional components and secondary metabolites.

c. Bidart et al. (2005) discovered that the diamondback moth (*Plutella xylostella*) only increased glucosinolate levels in *Arabidopsis thaliana* under elevated CO_2 conditions.

d. It has been reported that lepidopteran larvae prefer to feed on leaf tissue grown in ambient CO_2 conditions.

Elevated O_3 effects:

a. The combustion of fossil fuels, which emits nitrogen oxide gases and volatile organic compounds, which react with oxygen to produce O_3.

b. Unlike CO_2, which promotes overall plant growth, O_3 causes oxidative stress in plant cells, resulting in decreased plant photosynthesis, respiration, and growth, as well as nutrient changes.

Global warming effects:

a. Global warming refers to the increase in mean temperature observed since the mid-twentieth century as a result of anthropogenic greenhouse gas emissions into the atmosphere.

b. Temperature has a direct impact on the life cycle, growth and developmental rates, and insect distribution among plants and geographical locations.

Conclusions

1. The increase in mean temperature observed since the mid-twentieth century as a result of anthropogenic greenhouse gas emissions into the atmosphere is referred to as global warming.

2. The life cycle, growth and developmental rates, and insect distribution among plants and geographical locations are all affected by temperature.

3. Other research has discovered a decrease in female fecundity and pupal weight, as well as shorter developmental times in insects reared on high-temperature plants.

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Variable Rate Fertilizer Applicator - New Age Technology

Article ID: 40673

Kavya T[1], Sushilendra[1], Mareppa Hirekurubaru[1], Sunil Shirwal[1], Srigiri D[1]

[1]Department of Farm Machinery and Power Engineering, College of Agricultural Engineering, University of Agricultural Sciences, Raichur, Karnataka, India. Pin code: 584 104.

Introduction

India is the third largest producer and consumer of fertilizer in the world with an average consumption of 175 kg ha^{-1} (IFFCO, 2018). Macro nutrients availability in the soil is not the same throughout the field and varies from location to location. Constant uniform application of fertilizers leads to over fertilizing certain regions and under fertilizing others. So, there is a need to vary the fertilizer application rate based on analysis of information collected from the field. Fertilizers account 50 per cent of the total agricultural expenditure. Conventional methods (Broad casting) of application result in excessive loss which can be overcome by adapting precision agriculture. Precision agriculture uses detailed information within agricultural fields to optimize production inputs on a spatially variable basis, rather than to apply uniform applications across the entire field. Variable rate technology (VRT) plays an important role in precision agriculture. Existing seed cum fertilizer drills are not effective in varying the application rate of fertilizer. The VRA technology thus variably and automatically applies fertilizer as per requirement and highly cuts down the fertilizer wastage up to 35 per cent as in conventional approaches.

What is VRA and VRFA?

VRA is an abbreviation for variable rate application, which is a method of applying varying rates of inputs in appropriate zones throughout a field. The goals of VRA are to maximize profit to its fullest potential, create efficiencies in input application and ensure sustainability and environmental safety (Grisso *et. al.,* 2011).Variable rate fertilizer application system applies desired amount of input (fertilizer) precisely at right time and at a specific location to enhance crop production.The variable rate fertilizer applicator maps the fertilizer requirement at any location and required amount of fertilizer is applied by means of GPS and controller.

Functions of VRFA

1. To find the best fertilizer rate to match the crop and soil requirements.
2. To place the fertilizer as accurately as possible in the root zone or canopy.

Methods of VRA Technologies

The way in which the materials are applied is based on data that is collected by sensors, maps, and GPS. Variable rate application in precision agriculture can be map-based or sensor-based.

Map-Based VRA

Map-based VRA adjusts the application rate based on an electronic map, also called a prescription map. Using the field position from a GPS receiver and a prescription map of desired rate, the concentration of input is changed as the applicator moves through the field. Application rate can be adjusted based on a digital map of field properties. The tractormounted VRFA system consisted of a differential global positioning system (DGPS), micro-processor, microcontroller, DC motor, battery, threaded screw arrangement and fluted roller granular fertilizer applicator. The systemis based on prescription map of soil nutrients which is a digital data file containing specific information of latitude and longitude along with input rates to be applied. Chandel *et. al.,* (2016) found that application accuracy varied from 89.3% to 98.1%.

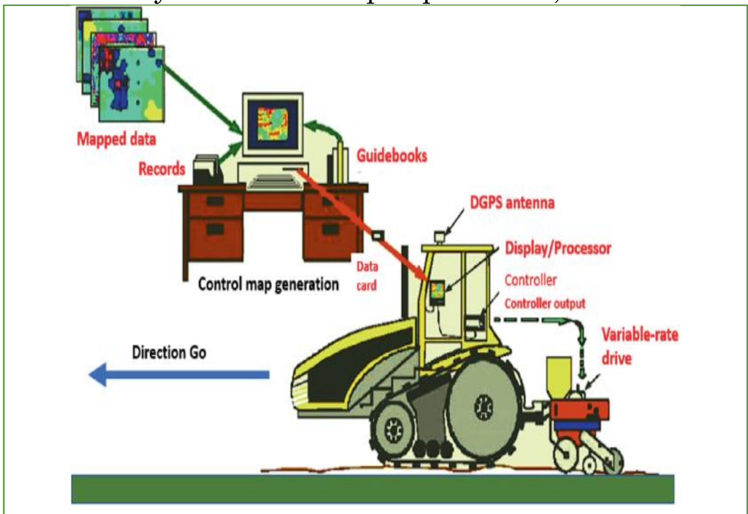
Benefits of Map-based Systems

1. Lack of sensors for monitoring soil and plant conditions
2. Application amounts can be determined in the office

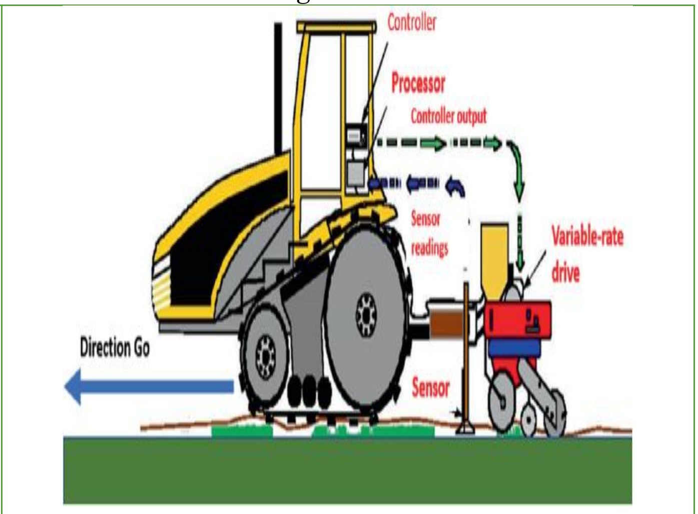
3. No danger of "running out"
4. No danger of mixing excess product
5. Permits processing of sampling data.

Drawbacks of Map-based Systems

1. Require a positioning system (*eg*: DGPS)
2. Sampling data must be collected, stored and processed
3. Specialized software needed to produce application maps
4. Application errors can result from:
   a. Recording the locations of sampling sites
   b. Estimating the position of an applicator as it moves through the field
   c. Not well suited when based on soil characteristics that change rapidly
   d. By the time a map is processed, the soil conditions could have changed.



A map-based system for varying crop input application rates



A sensor-based system for varying crop input application rates

Source: Belal *et. al.,* (2021)

Sensor-Based VRA

Sensor-based VRA requires no map or positioning system. Real-time sensors (*eg:*Greenseeker handheld sensor) on the applicator measure soil properties or crop characteristics "on the go." Based on this continuous stream of information, a control system calculates the input needs of the soil or plants and transfers the information to a controller, which delivers the input to the location measured by the sensor. The sensor-based method provides the capability to vary the application rate of inputs with no prior mapping or data collection involved. (Grisso *et. al.,* 2011).

Benefits of Sensor-Based VRA

1. Automation of the data analysis and interpretation.
2. A predetermined algorithm is used to convert the sensor information directly to an application rate. This algorithm is typically constant at a field scale and often at the regional scale (Taylor and Fulton, 2010).

Drawbacks of Sensor-Based VRA

Prescribed rate is constantly changing as the applicator moves across the field requiring the rate controller to respond quickly.

Advantages of Variable Rate Fertilization

1. Savings on fertilizers and chemicals.
2. Potential yield increase due to more efficient fertilization and spraying based on actual crop needs and variability of fields.
3. Environmental protection from excess fertilization or spraying of chemicals.

Disadvantages of Variable Rate Fertilization

1. It is more expensive
2. The information gathered by the systems can be complex and intricate, requiring a detailed knowledge of how to analyse the data and make use of it.

Conclusions

Variable rate fertilizer application is a promising technology through which; Crop yields, field performance and productivity in agricultural operations can be maximized. It could reduce environmental impact, making farming more sustainable. The collaboration of sensor-based applicator with the available map-based applicator would be a good idea to achieve more accuracy to apply precise amount of fertilizer in the field based on crop needs.

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Consumer Behavior Towards Online Shopping

Article ID: 40674

Sangya Singh[1]
[1]Ph.D. Scholar, Department of Resource Management and Consumer Science, College of Community Science, G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand.

Online shopping is the process consumers go through when they decide to shop on the Internet. The Internet has developed into a "new" distribution channel (Hollensen, 2004) and the evolution of this channel, e-commerce, has been identified by Smith and Rupp (2003) to be the most significant contribution of the information revolution. Using the Internet to shop online has become one of the primary reasons to use the Internet, combined with searching for products and finding information about them (Joines et al., 2003). Smith and Rupp (2003) also state that the consumers have never had access to so many suppliers and product/service opinions. Therefore, the Internet has developed to a highly competitive market, where the competition over the consumer is fierce. In order to have an impact on and retain consumers, in a competitive market, Constantinides (2004) stated that the first step is to identify certain influencing aspects when purchasing online, these can be regarded as factors.

At any given time, there are millions of people online and each of them is a potential customer for a company providing online sales. Due to the rapid development of the technologies surrounding the Internet, a company that is interested in selling products from its web site will constantly have to search for an edge in the fierce competition. Since there are so many potential consumers, it is of the out most importance to be able to understand what the consumer wants and needs. The importance of analysing and identifying factors that influence the consumer when he or she decides to purchase on the Internet is vital. Since the Internet is a new medium for there have been new demands set by the consumer. That is why it is crucial for the online retailers to know what influences the online consumer.

Analysing consumer behaviour is not a new phenomenon. The renowned marketing expert Philip Kotler has published several works on the topic of consumer behaviour theories. These theories have been used for many years not only to understand the consumer, but also create a marketing strategy that will attract the consumer efficiently. Hence, understanding and identifying the consumer is closely related to the directions a company will take with their marketing strategy. These theories can also be applied to identify the online consumer and to create certain consumer segments. However, some distinctions must still be made when considering traditional consumer behavior and online consumer behavior. Since online retailing is a new retailing medium and online consumer behavior is diverse from traditional consumer behavior, one must identify what influences the online consumer. Analyzing the process that the online consumer goes through when deciding and making a purchase over the Internet, shows some factors that consumers consider. These factors need to be identified and taken into account by online retailers in order to satisfy consumer demands and compete in the online market. To further understand how these factors influence different types of consumers, we must identify segments which will enable us to make comparisons.

When a consumer purchases a book online, he or she is affected by various factors. The main influencing factors have been identified as Price, Trust, and Convenience. The Price factor exists because prices are often lower on Internet stores compared to physical stores due to lower costs. Purchasing a book online can greatly benefit the consumer in terms of convenience and saving money. It is also convenient to shop on various book sites with different assortments, from the home. Trust is evidently needed since the consumer must share detailed personal and financial information when purchasing a book online. These types of data include the full name, delivery address and credit card number for example, which makes Trust an important factor. To be able to see how these factors affect consumers, we conducted a survey at the University of Kristianstad. We the found that the factor Price is of the highest concern to the students and that the factors Trust and Convenience had lower impact on the students. The decision was made to investigate if any segments could be found within the population sample. We identified three segments, High Spenders, Price Easers, and Bargain Seekers. We further investigated these segments and their overall attitude towards the factors Price, Trust, and Convenience it is clear that though majority of people are familiar with online shopping and make use of it, still there is a small portion of population who are unaware about this and doesn't use it. Even though people are almost satisfied with the online shopping they are faced with few problems like cheap quality of product and delay in delivery. Online shopping platforms should take necessary steps to rectify them. And also we understood that marketing strategies play a major role in boosting online shopping. Online shopping has increased considerably during the context of covid-19 and is gaining significance nowadays.

Since the consumer couldn't physically evaluate the product, the authorities of the online shopping sites should check the quality of the product before approving the product to put into sales.

1. The e-commerce companies and the respective courier services linked with the companies should try to eliminate delay in delivery of the product.
2. Authorities should avoid delay in refunding, product return and other related procedures.

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Geographical Indications in Horticulture: A Study in North East India

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Ram Preet Singh[1], S. Sunandita Patel[2]
[1]Ph.D. Scholar, Department of Fruit Science, College of Horticulture & Forestry, Central Agriculture University, Pasighat-791102, Arunachal Pradesh, India.
[2]Assistant Professor, Horticulture, Arunachal University of Studies, Namsai, Arunachal Pradesh, 792103.

Introduction

North East India is a biodiversity hotspot for horticulture crops. Geographical indications of horticultural products with specific geographical origin to north east India are very important in the current context since it preserves a product's qualities and reputation through market difference. Geographical indication (GI) is a mark imposed on items that have a particular geographic origin and have traits or a reputation that originate from that origin. A GI sign must identify a product as having originated in a specific location. Aside from that, the product's traits, characteristics, or reputation should be mostly related to its origin. Because the qualities vary according to the geographical location of production, there is a clear link between the product and its original location of production. A geographical indicator right allows individuals who have the right to use the indication to ban others from using it if their product does not meet the applicable standards (Chaudhary *et al.*, 2017). GIs in the horticultural sector include Darjeeling Tea, Kangra Tea, Tezpur Litchi, and others.

The Advantages of GI

1. Increased market price
2. A fair price for farmers
3. Consumers
4. Market encroachment
5. Conventional knowledge
6. Development of rural areas
7. Legal Defence
8. GI Protection.

Historical Development of GI

Before to TRIPS, there was no global agreement dealing with the protection of GI as such. The TRIPS Agreement (1994) is the first international legal instrument to include the term GI. The following definition is provided by the 1994 Agreement on Trade-Related Aspects of Intellectual Property Rights ("TRIPS Agreement"): "Geographical indications are, for the purposes of this Agreement, indications that identify a good as originating in the territory of a member of the World Trade Organization, or a region or locality within that territory, where a given quality, reputation, or other characteristic of the good is essentially attributable to its geographical origin." WTO members are free to include more comprehensive protection in their laws than is needed under TRIPS; nevertheless, any protection must not violate the Agreement's terms. The Geographical Indications (GI) of Goods (Regulation and Protection) Act was passed by the Indian Parliament in 1999 to facilitate registration and better protection of commodities. This Act went into force on September 15, 2003. According to Section 1(e), "Geographical Indication" in relation to goods means an indication that identifies such goods as agricultural goods, natural goods, or manufactured goods as originating or manufactured in the territory of a country or a region or locality in that territory, where a given quality reputation or other characteristic of such good is essentially attributed to its geographical origin, and in the case of such goods being manufactured goods, on the basis of their geographical origin. The Act focuses on the quality, reputation, or other characteristics of such commodities that are primarily attributable to their geographical origin (Chaudhary *et al.*, 2017).

Status of GI in Horticulture Sector of Northeast India

Fig. 1. Illustrating of GI tags crops

North East India, which consists of eight states, has a diverse range of fruits, vegetables, flowers, particularly orchids, spices, and medicinal plants. It is a popular tourist destination in India due to its diverse soil, climate, and topography. Northeast India has the greatest variety of commercial fruits, including citrus, bananas, and jack fruit. Other tropical and subtropical fruits found in North East India include Garcinia, Annona, Averrhoa, Persia, Aegle, Passiflora, and Tamarindus, among others. The region is also abundant in various genotypes of cucurbits, solanaceous vegetables, ginger, turmeric, bamboo, leafy vegetables, and other crops. The region had the greatest diversity in orchids, ferns, and other blooming plants among the various attractive horticultural crops. Nonetheless, indigenous, and minor horticultural crops grown in the region remain underutilized. According to the list of registered GIs, several states seized the chance and received GI tagging of their goods and production unique to their region. Northeast India, despite its great horticultural diversity, has been unable to benefit from GI labelling. Northeast India's horticulture output has gotten a boost, with as many as 12 goods receiving GI labels.

Naga Mircha: *Capsicum chinense* 3-year-old plant height is 12-13 feet. Based on morphological features and proteomic analyses, *Capsicum assamicum* was recently recognised as a separate species. Fruit hue Red, brown, and white red conical to semi-conical shape with rough wrinkle surface. With a Scoville heat unit (SHU) value of 1,001,304, it was the hottest chilli in the world in 2006. Pungency is reduced when cultivated in light conditions. Capsaicinoid content ranges from 2.45% to 5.36%. While other cultivars have less than 1% capsaicinoid, they are good for capsaicin extraction because 1% capsaicin is common for commercial extraction. The special traits are fruity scent, distinct pungency, and excellent unique flavour (Gogoi *et al*., 2018; Meetei *et al*., 2016).

Naga Tree Tomato: *Solanum betaceum* Perennial plant, used as a backyard enterprise crop. Tiny, sensitive 10-18 feet high tree with oval and egg-shaped fruits that grow in clusters. The fruit's colour ranges from red to orange, with the interior pulp being pale orange and the seeds being black. The fruit is typically 100 to 150 g in weight and has a sweet taste and resinous aroma. It has relatively thicker outer skin, less moisture content and long shelf life Helps to control high blood pressure and lowers cholesterol levels and flavour profile, with a unique flavour profile, with a uniqueness in terms of taste, with a unique flavour profile and (Rai *et al*., 2005; NERAMAC, 2014).

Arunachal Orange: Oranges grown in Arunachal Pradesh's climatic conditions *Citrus reticulata*: Trees grow between 3 - 6 m high. Fruit round with medium thick peel & weights 100 - 150g. Distinguished by loose skin of fruit, the relative ease with which the segments can be separated. High TSS & medium acidity provides unique sweet- sour taste. Orange colour at fruit ripening with high Vitamin C and high juice content (NERAMAC, 2014).

Sikkim Large Cardamom: *Amomum subulatum* is an important cash crop in Sikkim and Darjeeling. Perennial plant with 1.7 to 2.6 m aerial leafy branches and 9 to 13 leaves in each tiller. The inflorescence is a compact spike with 10-15 yellowish perianth fruits. Fruit is round or oval in shape, with a reddish-brown capsule. Shade-loving tree that promotes tree biodiversity conservation. Excellent quality due to the native environment and traditional curing procedure. The quality differs from small cardamom in that it contains less volatile oil and is more fibrous.

Mizo Chilli: *Capsicum frutescens A* bushy plant that can grow up to 120 cm tall. The leaves are smooth oval shaped. Fruit is a tiny, aromatic pod that matures to a dark crimson colour. At 37,153 SHU, it stands out due to its modest size. High 'K' levels in the jhum plains are responsible for the unique red colour. Field burning reduces weed growth, soft rot disease, and increases the availability of certain plant nutrients, particularly potash, which helps the crop develop properly and gives the final fruit a good colour. Pesticide residue-free Capsaicin content of 0.59%.

Karbi Anglong Ginger: *Zingiber officinale* is a herbaceous perennial with unbranched pseudo-stems or aerial shoots that reach 30-90 cm in height. Ginger is mostly grown two varieties: Nadia and Aizol. The Nadia variety is medium to bold in colour, light brown in colour, moderately pungent, and mild in flavour, with an Oleoresin content of 3.40%. Aizol is a large rhizome with low fibre content.

Fig. 2. Illustrating of GI tags crops

Tripura Queen Pineapple: *Ananas comosus* is a medium-sized (1.0-1.5 m) herbaceous perennial plant with 30 or more trough-shaped and pointed leaves 30-100 cm long. The fruits are spiny and orange yellow in colour. Fruits are oval and have a golden yellow pulp. Fruits that are smaller and have less fibre Not suitable for slices due to of its smaller size & deep eyes The juice content is 23.68%, the sugar content is higher but the acidity is lower (NERAMAC, 2014).

Tezpur Litchi: Tezpur Litchi is a type of litchi grown in the villages of Litchu Pukhuri and Porowa in Assam's Sonitpur district. Pleasant flavour, juicy pulp (aril) with a lovely colour.

Khasi Mandarin: *Citrus reticulata* is tiny evergreen trees with a distinct upright growth habit. Fruit globose to oblate in shape, with tight and silky skin. It is difficult to peel, but it has more flesh and juice. Medium-thick, loosely adherent rinsing with conspicuous, sunken oil glands orange flesh; if not picked when ripe, fruits lose quality and rind puffs. TSS (Brix) 11.56 and Acidity 0.64% make this a good source of vitamin C. (GI Registry Journal,2014).

Kachai Lemon: *Citrus jambhiri* is a high-yielding lemon landrace found in Manipur's Ukhrul district. Fruits are spheroid in shape, with individual fruits weighing 70 to 100 g and being yellow in colour. The fruit's distinctiveness stems from its habit of bearing. Even when ripe, it does not fall from the tree. Unpicked fruits remain on the tree and change colour throughout the next fruiting season (green to yellow). The rind is white, while the pulp is yellow. Fruit contains 46-51 mg of Ascorbic Acid per 100 ml of juice. TSS is 6.8 -10.5° Brix and Acidity 4.1-6.1% (MOMA, Govt of Manipur; GI Registry, 2014).

Assam (Orthodox) Tea: With its distinct aroma and robust, malty flavour, Assam tea is a popular beverage around the world. Teas "grown and manufactured in the Brahmaputra or Assam Valley in north east India from the basic *Camellia sinensis* var. assamica and other variants" Assam Orthodox Teas are rolled with machinery in a manner that mimics hand-rolling. The majority of specialty teas are produced using traditional methods. Two flushes, the first in March and the second in May-June. Colourful yellow with a distinct flavour (GI Registry Journal,2007).

Memang Narang: *Citrus indica* a tiny tree or shrub that grows to be 3-6 feet tall. Fruits range in size from spherical to depressed globose, having a smooth surface. When fully ripe, the fruits range from bright orange crimson to practically scarlet. Because it is virtually pest and disease free, it can be utilised as a rootstock. Fruits with a small size and an unpleasant flavour that are mostly used as medicine. Endangered species germplasm is maintained at the Reserve's National Citrus Gene Sanctuary at Nokrek Biosphere Reserve (GI Registry Journal, 2014).

Issues and Concern

GI status is not used after registration due to a lack of background work for filing and awareness. Inadequate branding and visibility initiatives There are no formal organisational structures or control procedures. Support is required in the areas of R&D, marketing, and so on. The following is the conclusion and future- prospects: Safeguard and capitalise on the market potential of reputable origin-linked items. Protection against unfair competition Inter-institutional collaboration and coordination that is effective It is critical to spread GI literacy today. Alternative for Increasing Farmers' Income Creating, registering, and enforcing a GI might take time and must be addressed. Tight adherence to rules and regulations.

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Odisha Millet Mission, Another Nutritious Cereal for Healthy Living

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Prerana Priyadarsini Choudhury[1]
[1]Department of Agronomy, Siksha 'O' Anusandhan, Deemed to be University, Bhubaneswar, Odisha.

Abstract
Major millets and lesser millets are referred to as Nutri-cereals because of their nutritious significance. These crops need little water, fertiliser, and produce less carbon during growth, making them short-lived and resource-efficient (Good for the farmer). Locally grown millets are nutritious foods with added health benefits, such as being a source of gluten-free protein, being high in fibre, having a low glycemic index, and being abundant in bioactive compounds. Because they contain a good amount of nutrients like complex carbohydrates (Low GI), proteins with balanced amino acids, dietary fibre, good-quality invisible fat, and noticeably higher amounts of micronutrients like calcium, potassium, magnesium, iron, manganese, zinc, B complex vitamins, and bioactive phytochemicals, nutri-cereals are a better choice than cereal grains like rice and wheat. Only traditional consumers in indigenous societies utilise millet as food, despite the fact that its nutritional advantages have been well documented. The main reason for this is that, unlike products made from wheat and rice, ready-to-use or ready-to-eat millet is not readily available to consumers. One step in that direction was the recent decision by the United Nations General Assembly to recognise 2023 as the International Year of Millets in order to highlight the importance of nutrient-rich crops in the face of climate change. Also, the creation of new processing tools and technological developments for the production of convenient foods from nutri-cereals are becoming more and more well-known on a global scale. This research focused on the breadth of nutria-cereal production, processing, and rural business development potential from India to the global market.

Introduction
The government of Odisha's Department of Agriculture and Farmers Empowerment has a flagship programme called the Odisha Millets Mission. The Odisha Millets Mission, a special programme for millets promotion in tribal areas of the state, was started by the government of Odisha in 2017.The Ministry of Agriculture and Farmers Welfare, Government of India, has rebranded the coarse cereals, such as sorghum, major millets, and other tiny millets, as Nutri-cereals. It is believed that changing the name will debunk the persistent myth that these grains are superior than rice and wheat and are a plentiful source of phytochemicals and minerals [1]. Major millet crops grown for sorghum (Sorghum bicolor) include bajra or pearl millet (Pennisetum typhoides), mandua/ragi or nger millet (Eleusine coracana), and small millets such as kangni or foxtail millet (Setaria italica), kutki or sama or little millet (Panicum miliare), kod (Echinochloa frumentacea)The main cereals grown in India that are more nutritious than other major cereals include kodo millet (Paspalum scrobiculatum), jhangora or sawan or barnyard millet (Echinochloa frumentacea), cheena or proso millet (Panicum miliaceum), and korale or brown top millet (Brachiaria ramosum). Smart Meals include millets [2]. Due to their nutritional value (good for humanity), minimal water and fertiliser requirements, low carbon emissions during crop growth (good for the environment), and short duration and resource efficiency, these crops are a good choice (Good for the farmer). Millets provide additional health benefits, such as being a source of gluten-free protein, and are a locally grown healthy food since they are more nutrient-dense than other major cereal grains.

Keywords: Functional foods, Millets, Malnutrition, Nutri-cereals, Processing.

Why Many Organizations Have Praised the Odisha in Millets Mission?
For the purpose of promoting millets, pulses, and oilseeds, the Indian government has requested that all states replicate the model of the Odisha Millets Mission. A millet mission modelled after the "Odisha Millets Mission" has been requested by the Chhattisgarh State Planning Commission. The Government of India has established a task force to comprehend the Odisha Millets Mission's organizational structure and

to update the National Sub Mission on Millets in light of the OMM's lessons learned. Odisha Millets Mission and Cambridge University collaborated to investigate the viability of designing OMM as a replacement for the Green Revolution framework. The Maharashtra Governor has requested that the state government investigate starting a millets initiative in light of the Odisha Millets Mission. The Odisha Millets Mission's framework has received support from UN-IFAD and UN-FAO as being appropriate for launching agro-ecological activities.

Objectives

1. Fostering domestic consumption
2. Maintaining and promoting millet landraces
3. Putting in place a decentralised processing unit
4. How to Increase Millet Crop Productivity
5. Support for Millet Value-Added Businesses
6. Market facilitation and FPO promotion
7. Millets being included to ICDS, MDM, and PDS
8. Community Seed Centers with Local Landrace Participatory Varietal Trials per Block
9. Processing Units at the General Purpose (GP), Block, and Cluster Levels, and Bespoke Hiring Centers
10. SNP-ICDS, MDM, and PDS inclusion
11. Campaign to Promote Consumption at the Village, Block, Dist., and State Levels Using SHGs, Market Links, and Value Addition
12. Agronomy Improvements in Millet Crops Over 1000 Ha Per Block (SMI, Line Transplanting and Line Sowing).

Components of Millet Mission

The unit of implementation: In the course of five years, each block should span at least 1000 Ha. Contiguous clusters will be used to fill this space. Farmers must have 0.2 hectares of land at a minimum. 2 Ha is the maximum acreage per farmer. The programme anticipates directly reaching at least 1000 households in a block. Program will use production, consumption, processing, and FPO promotion activities to reach 4000 homes each block.

Promoting household level consumption: By holding cooking competitions based on regional customs and festivals, millets' consumption will gain reputation. Exposure to diverse cooking methods through training, food events, and promotions. Encouraging local businesses to market baked goods and ready-to-eat millets like Ladoos and Murukku. Initiatives to raise awareness of the nutritional benefits of millets among many stakeholders, particularly among mother committees of programmes for women and children and school-age children. Convergence sessions with District/Block level authorities to discuss the government's adoption of millet in various supplemental nutrition programmes.

Increasing Millet Crop Productivity:

a. To make excellent seed easily accessible and in time, diverse seed centres are being established. With the appropriate Research Stations, the Seed Centers will be connected. The Seed Centers engage in a variety of tasks, such as:

   i. Participatory varietal trials are used to select, purify, and multiply high-performing local cultivars.
   ii. Creating and honing "Seed Farmers" with specialised knowledge for the multiplication, preservation, and dissemination of new types, and organising them with Seed Centers
   iii. Examples of purified, enhanced, and new seed varieties
   iv. Preservation and expansion of indigenous seed varieties.

b. Improved agronomic practices: Together with the enhanced set of procedures, the following have demonstrated promise.

   i. Introducing a suitable System of Millet Intensification
   ii. Promotion of Line Transplanting/ Line sowing/ Inter-cropping with millets
   iii. Using bio manure, composting, and in-situ techniques will improve crop nutrition.
   iv. Practices for controlling pests and diseases that follow the NPM

v. Additional organic or agricultural activities as considered essential by the needs of the local area

vi. Assistance to the farmers. The skilled individual will be referred to as CRPs. The most effective method of distribution is farmer to farmer learning.

Government of Odisha has Approved Pilot Procurement Ragi through FPOS in 16 Blocks in 7 Districts

1. FPOs shall handle registration of the farmers, encourage the awareness generation on ragi procurement, enable the manpower for loading and unloading and oversee the procurement process and generation of receipts in their particular blocks.

2. UN-FAO and MoA-NRAA are also sponsoring and researching the purchase of ragi through FPO in Komana block in Nuapada district. UN-FAO and MoA-NRAA are investigating the service-centric FPO model of OMM as an institutional tool for circular economy.

3. For the purpose of selecting FPOs for the chosen pilot blocks, a thorough selection/screening process was carried out. To manage the procedure, a district-level committee was established comprising representatives from TDCCOL, WASSAN, and ATMA.

Inclusion of Ragi Ladoos to Start in Keonjhar as Part of Odisha Millets Mission (OMM)

1. In the presence of DSWO madam and Dr. Usha Dharamraj from CFTRI, Mysore, a technical assessment of the Chhatua-making plant managed by Radhakrishna SHG, Sadar block, was also completed in order to put up machinery for the inclusion of ragi ladoos.

2. According to interactions with stakeholders and observations made during field trips, it is practical to implement the addition of ragi ladoos in ICDS in Keonjhar.

3. While it is challenging to implement millets (jowar and tiny millet) in hot prepared meals with existing capabilities. After streamlining the inclusion of ragi ladoos in ICDS, it will be tackled piecemeal.

4. Following the pilot's execution, it will gradually be implemented in the other OMM districts. After the pilot is put into practise, it will be gradually implemented in the other OMM districts. The Collector & DM, Keonjhar, must get a comprehensive action plan for review.

"Mandia"- The Mascot of Krushi Odisha 2020 of Government of Odisha

In the rainfed areas of Odisha, millets were a common crop. They were particularly significant to indigenous communities' diets. Millets are crops with strong nutritional content and are climatically adaptable. They supported the nutritional security of the tribal populations and lessened drought seasons.

Conclusion

Due to their rich nutritional profile, nutri-cereals are promoted as healthy foods due to their revitalised role in combating malnutrition and lifestyle diseases, the benefits of including them in publicly funded programmes for the development of women and children, and the growing awareness of the enormous potential for export markets, particularly in the midst of the Covid-19 pandemic. A recent decision by the UN General Assembly to recognise 2023 as the International Year of Millets in order to highlight the significance of nutrient-rich crops in the face of climate change is a step in the right direction. Moreover, nutritional cereals are taking the lead globally. The Indian government has decided to market their traditional food basket to the rest of the globe.The government of India was given the task of stepping up itsefforts to increase millets production and area, diversify its processing equipment and technologies, grow the ecosystem of private food processors, and thus serve the needs of various domestic and international market segments. It is assumed that the rest of the world is interested in India's traditional foodbasket.

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Dash Diet: A Guide to the Scientific Plan for Lowering Hypertension

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Fauzia Bano[1], Seema Kanojia[2], Minhaj A. Usmani[3]
[1,2]Research Scholar, Department of Food and Nutrition, Era University, Lucknow, 226003.
[3]Associate Professor, Department of Food and Nutrition, Era University, Lucknow, 226003.

Introduction

High blood pressure (hypertension) is one of the most important and common risk factors for atherosclerotic cardiovascular disease (CVD) and other chronic diseases. Currently, hypertension is thought to affect roughly 50 million people in the U.S. and approximately 1 billion worldwide according to the National Heart, Lung and Blood Institute (NHLBI), (blood pressure of 140/90 mmHg or higher), many more individuals are at increased risk for CVD because their blood pressure levels are above optimal (>120/80 mm Hg). Extensive data show that increased blood pressure is related to increased risk of CVD through a broad range of blood pressures, beginning at levels previously designated above optimal, but not yet hypertensive. The Seventh Report of the Joint National Committee (JNC) on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) recommends that all individuals with blood pressure readings of 120/80 mm Hg or higher adopt lifestyle modifications to help prevent or manage hypertension.

It is recognised that a number of lifestyle choices can lower blood pressure. These include a diet rich in fruits, vegetables, low-fat dairy products, and low in fat (i.e. the Dietary Approaches to Stop Hypertension [DASH] diet), losing weight, consuming less sodium, engaging in regular physical activity, and consuming alcohol in moderation.

The Dash Diet – What is it?

This is a disease specific dietary formula found to be more effective on lowering hypertension than simply adding fruits and vegetables. After conducting several trials it has been announced as physiologically safe for treatment. Dash diet is framed with more fruits and vegetables, non-fat dairy, nuts. In the Dietary Approaches to Stop Hypertension trial (DASH), lifestyle modifications such as exercise, a diet low in sodium, saturated fat, cholesterol, and high in potassium, calcium, fiber, fruits have clearly been shown to decrease BP.

The DASH diet recommends keeping salt intake to less than 2300 mg (1500 mg a day – elderly). Excessive sodium intake is particularly deleterious in patients with diabetes because it may decrease the antihypertensive effects of medications and their beneficial effects on proteinuria. Also, DASH diet has beneficial effects for diabetes control and prevention of complications apart from pressure control. Research studies show, the DASH diet lowered the blood pressure within 2 weeks.

Two experimental diets were selected for the DASH study and compared with each other, and with a third: the control diet. The control diet was low in potassium, calcium, magnesium and fiber and featured a fat and protein profile so that the pattern was consistent with a "typical American diet at the time". The first experimental diet was higher in fruits and vegetables but otherwise similar to the control diet (a "fruits and vegetables diet"), with the exception of fewer snacks and sweets. Magnesium and potassium levels were close to the 75th percentile of U.S. consumption in the fruits-and-vegetables diet, which also featured a high-fiber profile. The second experimental diet was high in fruits and vegetables and in low-fat dairy products, as well as lower in overall fat and saturated fat, with higher fiber and higher protein compared with the control diet—this diet has been called "the DASH diet". The DASH diet (or combination diet) was rich in potassium, magnesium and calcium—a nutrient profile roughly equivalent with the 75th percentile of U.S. consumption. The combination or "DASH" diet was also high in whole grains, poultry, fish, and nuts while being lower in red meat content, sweets, and sugar-containing beverages.

The DASH diet was designed to provide liberal amounts of key nutrients thought to play a part in lowering blood pressure, based on past epidemiologic studies. One of the unique features of the DASH study was that dietary patterns rather than single nutrients were being tested. The DASH diet also features a high quotient of antioxidant-rich foods thought by some to retard or prevent chronic health problems, including cancer, heart disease, and stroke.

Researchers have also found that the DASH diet is more effective than a low-oxalate diet in the prevention and treatment of kidney stones, specifically calcium oxalate kidney stones (the most common type).

Starting the DASH Diet

Fruits, vegetables, low-fat or fat-free dairy, whole grains, fish, poultry, legumes, and nuts are the key components of the DASH diet. It advises scrimping on red meat, sugars (in drinks and foods), and sodium. It restricts consumption of saturated and trans fats while promoting consumption of potassium, magnesium, protein, fibre, and other nutrients known to help regulate blood pressure.

A specific amount of servings per day from various food groups are advised by the DASH diet. Depending on the daily calorie needs, the serving size may vary. DASH adoption might happen gradually. Start with, for instance, 2,400 milligrams of sodium (or about 1 teaspoon) each day. After then, it can be changed to 1,500 milligrams (or roughly 2/3 teaspoon) of salt each day. The salt supplied throughout the day's preparation must be in the required quantity. In addition to regular intake, one serving of vegetables at lunch and dinner is required.

As a snack, include one serving of fruit. 6 ounces of meat maximum each day. Prepare some vegetarian dishes.

The NHLBI (National Heart, Lungs, and Blood Institute) provides sample plans with specific number of servings based on 1600, 2000 or 2600 calories per day. Here is the sample plan for 2000 calories daily.
1. 6–8 servings of grains or grain products (preferable whole-grain).
2. 4–5 servings of fruits
3. 4–5 servings of vegetables
4. 2–3 servings of low-fat dairy foods
5. 2–3 servings of fats and oils
6. 2 or fewer servings of meat, poultry or fish

With the following weekly limitations:

a. 4–5 servings of nuts, seeds or dry beans
b. Sweets, desserts, food with added sugars limited to a maximum of 5 servings
c. Following this diet requires some planning ahead and cooking. To ease this, both the NHLBI and NIH (National Institute of Health) maintain lists of healthy recipes.

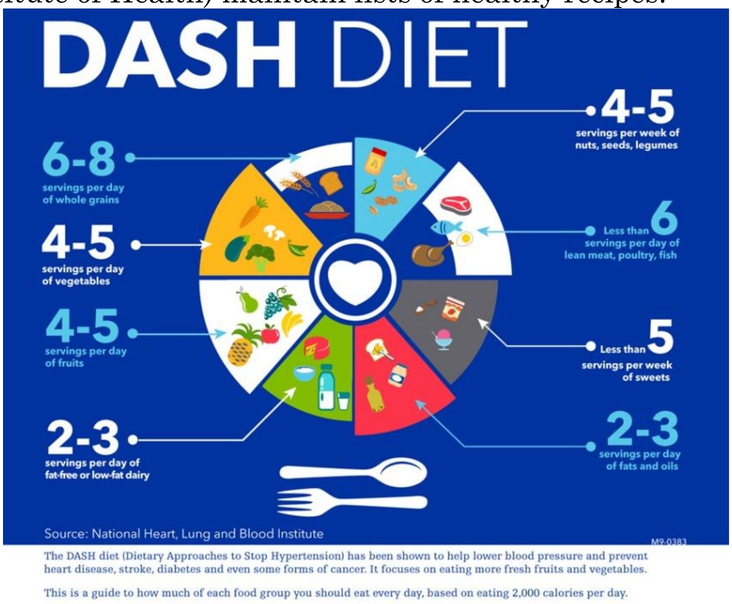

Fig.1: DASH Diet, specific numbers of servings

The DASH Trial

The DASH trial studied a sample of 459 adults with above optimal diastolic blood pressure or stage 1 hypertension. All study foods were provided to the participants. The primary outcome measure was change in blood pressure between the end of run-in and the end of an 8-week controlled feeding period.

The DASH trial compared the effects on blood pressure of three dietary patterns: a control diet similar to what many Americans consume; a diet high in fruits and vegetables, but otherwise similar to the control diet; and the DASH dietary pattern. The DASH dietary pattern is high in fruits, vegetables, and low-fat dairy products, and reduced in fats, red meat, sweets, and sugar-containing beverages. Compared with the control diet, the DASH diet has lower levels of total fat, saturated fat, and cholesterol, and higher levels of potassium, calcium, magnesium, fiber, and protein. The trial's intermediate (fruits and vegetables) dietary pattern was designed to test the blood pressure-lowering effect of fruits and vegetables. The trial was conducted in three phases: screening, run-in, and intervention. The run-in phase was a 3-week period during which all participants were given the control diet. The intervention phase lasted 8 weeks, during which participants followed their assigned diets; they were not told their diet assignment. A 7-day menu cycle included 21 meals at four calorie levels for each dietary pattern to accommodate a range of energy requirements. More than 95% of the 459 randomized participants completed the intervention phase and attended on-site meals.

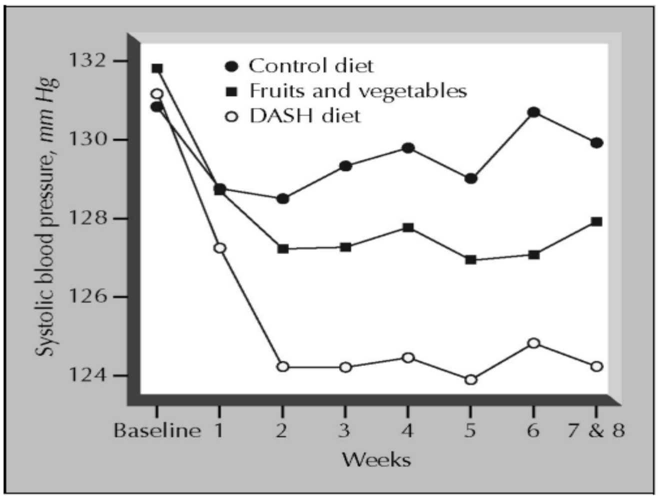

Fig.2: Mean systolic blood pressure at baseline and during each intervention week, according to the Dietary Approaches to Stop Hypertension (DASH) diet, for 379 subjects with complete set of weekly blood pressure measurements [3].

The DASH diet quickly and significantly lowered blood pressure compared with the control diet, whereas the fruit and vegetable diet reduced blood pressure by about half as much (Fig. 1). Blood pressure measurements were also taken for 24 hours with ambulatory blood pressure monitors, and the DASH diet was found to lower blood pressure throughout the day. The effects of the DASH diet on blood pressure held for a variety of subgroups. The effects of the DASH diet were especially pronounced in individuals with stage 1 hypertension, in whom blood pressure was reduced on average by 11.4/5.5 mm Hg.

Conclusion

According to the DASH trial, eating a diet high in fruits, vegetables, low-fat dairy products, and other plant-based foods can significantly lower blood pressure in people. These outcomes were attained without subjecting participants to calorie restriction or sodium restriction. The DASH-Sodium trial validated the results of the DASH study and found that the DASH diet decreases blood pressure at higher, intermediate, and lower dietary sodium levels. A low-sodium diet and the DASH diet were found to have stronger combined effects on blood pressure than the effects of either intervention alone**.** Along with lowering blood pressure, the DASH eating pattern also reduces other risk factors for cardiovascular disease. Due to the DASH diet's high fibre intake and emphasis on whole grains, it decreases total and LDL cholesterol without raising triglycerides. The DASH diet lowers HDL cholesterol, as do other low-fat, high-carb dietary patterns, but it also lowers homocysteine blood levels thanks to its high fruit and vegetable intake. Overall, the DASH diet may lower the risk of CVD.

Blood pressure can be greatly lowered by leading a healthy lifestyle that incorporates the DASH eating pattern, a healthy weight, less sodium intake, more regular exercise, and moderate alcohol use. Many people find it challenging to maintain these changes in daily life. Nevertheless, having a variety of options should ensure that at least one of them will be appealing enough to be chosen by those who are concerned about their health. Encouragement from societal institutions, healthcare systems, and health organizations can be beneficial. The risk of CVD and other chronic diseases, such as diabetes, osteoporosis, and maybe cancer, can be significantly reduced by making these lifestyle modifications. The DASH diet is a significant step in controlling blood pressure and maintaining overall health.

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Physiological Aspects of Plantation Beverage Crops

Article ID: 40678

Chandranshu Kastury[1]

[1]Ph.D. Scholar, Department of Botany, Plant Physiology and Biochemistry, College of Basic Sciences and Humanities, Dr Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar.

Summary of Article

A nice cup of tea or coffee gives a good start to the day. This is the opinion of almost every person in the world. Besides these two crops, cocoa is another crop which is either consumed as beverage or used for the production of all-time favourite chocolate which is mostly preferred as dessert. These three crops have one thing in common which is their caffeinated nature.

Introduction

Plantation crops are an important category of crops under horticultural study. The diverse agro climatic conditions of India allow cultivation of various plantation crops which are utilized for varied purposes. One of the important categories of these plantation crops based on utility is beverage crops. A beverage is a liquid intended for human consumption. Three beverage crops namely tea, coffee and cocoa are grown in plantations. Out of these three, the first two are grown on a large scale in our country and are responsible for very high export earnings. Tea is grown in north-eastern as well as southern regions, while coffee is limited to only southern states of the country. However, the production of cocoa is very limited in our country and it is cultivated in the states of Kerala, Karnataka and Tamil Nadu. All these crops come under the Ministry of Commerce & Industry, Government of India.

Tea

Tea (*Camellia sinensis* L. Kuntze) belongs to the family Theaceae. Its two important varieties which are widely grown in Asian countries are Assam tea and Chinese tea. The economically important part of tea is its leaves, especially the young leaves. Based on its morphology, tea leaves are classified into janam, fish leaf and mother leaf. Shoots may be plucked above janam, fish leaf or mother leaf and plucking systems are named accordingly. Plucking system determines the amount of maintenance foliage left on the bush. Based on processing procedure adopted, tea is then classified as white, yellow, green, oolong, black and dark. Tea contains caffeine (3%) as the major alkaloid. It also contains small amounts of theobromine and theophylline.

Coffee

Coffee (*Coffea* spp.) belongs to the family Rubiaceae. It is the second important commodity in international trade after petroleum products. The two most popular varieties of coffee grown all over the world are Arabica coffee and Robusta coffee. Coffee is grown for its beans which are botanically its seeds. Arabica coffee accounts for 75% of the global coffee production, rest 25% comes from Robusta coffee. Shade management is an important aspect of coffee cultivation as it determines the taste and aroma of coffee beans as well as foliar health of the plant. It also aids in controlling the microclimatic conditions of the plantation. Coffee is rich in caffeine, but Arabica coffee has lesser caffeine content than Robusta coffee.

Cocoa

Cocoa (*Theobroma cacao* L.) belongs to the family Sterculiaceae. Chocolate, the most popular food stuff in the world, is made by fermenting and roasting the seeds of cocoa to develop the characteristic flavour. There are three cocoa varieties which are cultivated around the world. They are Criollo, Forastero and Trinitario. Criollo and Forastero are naturally evolved varieties and Trinitario has the characters of both. Cocoa beans contain theobromine which is a caffeine alkaloid. Chocolate also contains phenylethylamine which is a natural amphetamine found in human brain. It produces euphoric effect upon consumption and thus it is reported to relieve stress.

Conclusion

Tea, coffee and cocoa are consumed by human beings because of the presence of secondary metabolites, mainly caffeine. It is a central nervous system stimulant of the methylated xanthine class and the most widely consumed psychoactive drug. Theobromine and theophylline also belong to the category of methylated xanthines. Caffeine reversibly blocks the action of adenosine on its receptor and consequently prevents the onset of drowsiness induced by adenosine. Although tea, coffee and cocoa are widely consumed all over the world, yet the secondary metabolites present in them have their own pros and cons. On one hand, the phenolic compounds found in these beverages induce a sense of relaxation by causing alterations in glucose homeostasis. But on the other hand, a long term excessive consumption of these beverages often leads to caffeine addiction.

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Millets as Climate Resilient Crops

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Chandranshu Kastury[1]

[1]Ph.D. Scholar, Department of Botany, Plant Physiology and Biochemistry, College of Basic Sciences and Humanities, Dr Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar.

Summary of Article

Millets are becoming popular among farmers and agriculturists in recent times, not only because they are highly nutritious but also, they can endure the adverse climatic conditions of the present.

Introduction

The yesterday's coarse cereals called millets have been long forgotten owing to the global popularity of the major cereal crops (wheat, maize and rice), especially after the Green Revolution of the 1960s. However, the recent global warming and climate change is leading to erratic weather patterns which are imposing threat on the production of these three staple crops of the world. Numerous reports and climate prediction models suggest that the agricultural productivity will be drastically affected in the future by the global climatic changes. Farmers are reporting the various problems faced by them in the cultivation of crops which are mainly due to biotic and abiotic stresses.

Climate Resilient Agriculture

The Industrial Revolution which commenced from 1750s, had a severe impact on our planet's health. The burning of fossil fuels caused the emission of greenhouse gases leading to the greenhouse effect which raised the mean temperature of earth by 1°C since then. Although it seems insignificant at first, but when this temperature rise is compared with the temperature over the span of millions of years, then it seems extremely alarming. The greenhouse effect led to the global climate change. Weather extremes like heat waves, cold waves, floods, droughts, etc. are increasing in intensity and frequency. Seasonal shifts are evident around the world which are affecting the cropping seasons. These abiotic stresses are also affecting the microbial and pests attacks on the crops. Many of them have developed enhanced virulence favored by the seasonal shifts.

Climate resilient agriculture is the approach of obtaining agricultural productivity in the event of climate change. It refers to the adaptation and recovery of the agricultural system in the presence of seasonal and weather extremes. This approach aims to provide food security to the ever-growing population through the sustenance of agricultural system in the already present changing environment. Cultivation of tolerant crops along with water and nutrient management are the basic strategies adopted in climate resilient agriculture.

Millets as the Answer

Millets are a category of cereals which have been cultivated by the humans since prehistoric times. They are the staple food of rural and tribal people in the underdeveloped and developing countries. They are highly nutritious and rich in several vitamins and minerals. However, the one aspect which has regained their popularity in the recent times, is their ability to grow in extreme environmental stress conditions. They require very less water for their growth which presents them as favorable crops for cultivation in water deficit and drought prone areas. Along with this, their nutrient requirement is very low. Therefore, they generally do not need input of chemical fertilizers. This aids in management of soil health where millets are grown. This is also a reason why small, marginal farmers prefer growing millets as the inputs costs are greatly reduced. The hardy nature of these crops help to protect them from various microbial and pests attacks. Therefore, pest management costs are also rarely incurred in their cultivation. All these factors make them a much favorable option for poor farmers living in extreme regions of developing and underdeveloped countries who cannot bear the cost of production of major cereal crops like wheat, rice and maize, whose input costs are too high.

Conclusion

The overall conclusion is that millets are a long-forgotten answer to the problems of climate change affected agriculture as well as quality and quantity food for the growing world population. These crops are capable of growing in limited resources in extreme weather conditions without needing much care and inputs. Therefore, they are a perfect solution for climate resilient agriculture.

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An Article on Effect of Fertigation and Micro Irrigation on Growth and Yield of Vegetable Crops

Article ID: 40680

Aibel H. Pallan[1], Dr. Yadvendra Pal Singh[1]
[1]School Of Agriculture, Lovely Professional University, Punjab.

Article

This article examines the effects of fertigation and micro-irrigation on the growth and yield of vegetable crops. Fertigation, which involves the application of water and nutrients through an irrigation system, has been shown to have a positive effect on the growth and yield of different vegetable crops, including tomatoes, cucumbers, peppers, lettuce, broccoli, and carrots. Fertigation allows for precise control of nutrient application, leading to efficient nutrient uptake and improved crop quality. Additionally, micro-irrigation systems, such as drip irrigation, can further enhance the effects of fertigation by providing precise water application and reducing water waste. The article concludes that fertigation and micro-irrigation are effective techniques for improving the growth and yield of vegetable crops, leading to increased profits for farmers and reduced environmental impact.

Introduction

Fertigation and micro-irrigation are two modern techniques that have been widely adopted by farmers worldwide to enhance the growth and yield of vegetable crops. Fertigation is the application of fertilizer and water through the irrigation system, while micro-irrigation involves the precise application of water and nutrients to the root zone of the plant. This review article aims to examine the effects of fertigation and micro-irrigation on the growth and yield of vegetable crops, with a focus on recent research findings.

Effects of Fertigation on Growth and Yield

Fertigation has been shown to have positive effects on the growth and yield of vegetable crops. Several studies have reported that fertigation can increase plant growth, root development, and yield compared to traditional methods of fertilization. For instance, a study by Khan et al. (2019) found that fertigation with nitrogen and potassium increased the growth and yield of cucumber plants. Similarly, a study by Singh et al. (2018) showed that fertigation with phosphorus and potassium increased the yield of tomato plants.

Fertigation also allows for more precise control of nutrient application, reducing the risk of over or under fertilization. This is particularly important for crops that have high nutrient requirements, such as tomato and cucumber. Furthermore, fertigation can increase nutrient uptake efficiency by the plants, leading to more efficient use of fertilizer and reduced environmental pollution.

Effect of Fertigation on Different Vegetable Crops

Tomatoes: Tomatoes are one of the most popular vegetable crops grown worldwide. Fertigation has been shown to have a positive effect on the growth and yield of tomato plants. Studies have shown that fertigation with phosphorus and potassium can increase the yield of tomato plants (Singh et al., 2018). Additionally, fertigation can improve the quality of tomatoes, including fruit size, color, and nutrient content.

Cucumbers: Cucumbers are another widely grown vegetable crop that can benefit from fertigation. Studies have shown that fertigation with nitrogen and potassium can increase the growth and yield of cucumber plants (Khan et al., 2019). Fertigation can also improve the quality of cucumbers, including fruit size, color, and nutrient content.

Peppers: Peppers are a popular vegetable crop that can also benefit from fertigation. Studies have shown that fertigation can increase the yield of pepper plants (Sarmiento et al., 2020). Additionally, fertigation can improve the quality of peppers, including fruit size, color, and nutrient content.

Lettuce: Lettuce is a leafy green vegetable crop that can benefit from fertigation. Studies have shown that fertigation can increase the yield of lettuce plants (Bouzas-Cid et al., 2016). Additionally, fertigation can improve the quality of lettuce, including leaf size, color, and nutrient content.

Broccoli: Broccoli is a vegetable crop that can benefit from fertigation. Studies have shown that fertigation with nitrogen and potassium can increase the yield of broccoli plants (Singh et al., 2017). Additionally, fertigation can improve the quality of broccoli, including head size, color, and nutrient content.

Carrots: Carrots are a root vegetable crop that can also benefit from fertigation. Studies have shown that fertigation can increase the yield of carrot plants (De Pascale et al., 2017). Additionally, fertigation can improve the quality of carrots, including root size, color, and nutrient content.

Benefits of Fertigation

1. Fertigation has several benefits for vegetable crops, including:
2. Precise nutrient application: Fertigation allows for precise control of nutrient application, reducing the risk of over or under fertilization.
3. Efficient nutrient uptake: Fertigation can increase nutrient uptake efficiency by the plants, leading to more efficient use of fertilizer and reduced environmental pollution.
4. Improved crop quality: Fertigation can improve the quality of vegetable crops, including size, color, and nutrient content.
5. Increased crop yield: Fertigation can increase the yield of vegetable crops, leading to higher profits for farmers.

Effects of Micro-Irrigation on Growth and Yield

Micro-irrigation has also been shown to have positive effects on the growth and yield of vegetable crops. The precise application of water and nutrients to the root zone of the plant reduces water loss due to evaporation and run-off. This results in more efficient water use, which is especially important in regions with water scarcity.

Several studies have reported that micro-irrigation can increase plant growth and yield compared to traditional irrigation methods. For example, a study by Sarmiento et al. (2020) showed that micro-irrigation increased the yield of pepper plants. Similarly, a study by Han et al. (2020) found that micro-irrigation improved the growth and yield of sweet potato plants.

Micro-irrigation also reduces the incidence of soil-borne diseases and pests by limiting the amount of moisture in the soil. This is because many soil-borne pathogens require high moisture levels to thrive. Furthermore, micro-irrigation reduces the amount of weed growth by limiting the amount of water available to weeds.

Combined Effects of Fertigation and Micro-Irrigation

The combined use of fertigation and micro-irrigation has been shown to have synergistic effects on the growth and yield of vegetable crops. This is because fertigation allows for the precise application of water and nutrients to the root zone of the plant, which is facilitated by micro-irrigation. The combination of these two techniques allows for more efficient use of water and fertilizer, resulting in increased crop yields.

Several studies have reported that the combined use of fertigation and micro-irrigation can increase the growth and yield of vegetable crops compared to traditional methods of irrigation and fertilization. For example, a study by Zhang et al. (2021) showed that the combined use of fertigation and micro-irrigation increased the yield of cucumber plants compared to traditional methods of fertilization and irrigation.

Conclusion

In conclusion, fertigation and micro-irrigation are two modern techniques that can enhance the growth and yield of vegetable crops. Fertigation allows for more precise control of nutrient application, reducing the risk of over or under fertilization, while micro-irrigation reduces water loss due to evaporation and run-off, resulting in more efficient water use.

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An Article on Impact of Fertigation in Modern Agriculture

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David j Olakkangal[1], Dr. Yadvendra Pal Singh[1]
[1]School Of Agriculture, Lovely Professional University, Punjab.

Article

Modern agriculture in India is characterized by a mix of traditional farming practices and modern technologies. The agricultural sector in India employs approximately 50% of the country's workforce and is a major contributor to the national economy. Fertigation is a modern agricultural practice that involves the precise application of fertilizers through irrigation systems. It has become an increasingly popular method of fertilization due to its efficiency, environmental sustainability, and ability to improve crop yields. Fertigation enables farmers to apply fertilizers in controlled amounts, reducing the risk of over-fertilization and minimizing wastage.

Modern Agriculture

India has a long history of agriculture, with farming being the main occupation of many rural communities. However, in recent years, the agriculture sector has undergone a transformation, with the adoption of modern agricultural practices and technologies.

One of the most significant developments in modern agriculture in India was the Green Revolution of the 1960s and 1970s. This movement saw the introduction of high-yield crop varieties, use of fertilizers and pesticides, and mechanization of farming practices. These developments led to significant improvements in crop yields and helped India achieve self-sufficiency in food production.

The use of modern irrigation systems has also been a game-changer for Indian agriculture. Drip irrigation and sprinkler systems have improved water use efficiency and increased crop yields, particularly in water-stressed regions of the country.

Biotechnology has also played a significant role in modern agriculture in India. The country has been a pioneer in genetically modified crops, with the development of Bt cotton and Bt brinjal. These crops have been credited with improving yields and reducing the use of chemical pesticides. However, there has been some controversy surrounding the use of GM crops in India, with concerns over their safety and impact on the environment.

In recent years, there has been a growing trend towards organic farming in India. Farmers are adopting sustainable and environmentally friendly farming practices, which are seen as an alternative to the use of chemical fertilizers and pesticides. This has led to the development of organic farming clusters across the country, with some states, such as Sikkim, aiming to become fully organic.

The government of India has implemented several policies and initiatives to promote modern agriculture in the country. The National Mission for Sustainable Agriculture, Rashtriya Krishi Vikas Yojana, and Pradhan Mantri Fasal Bima Yojana are some of the schemes aimed at increasing productivity, improving farmers' incomes, and promoting sustainable agriculture practices.

Despite the advances in modern agriculture in India, the sector faces several challenges. Small landholdings, low productivity, lack of mechanization, and climate change are some of the major challenges that need to be addressed. However, the Indian government and private sector are working towards overcoming these challenges and promoting sustainable agriculture practices in the country.

Despite the advances in modern agriculture in India, the sector faces several challenges, including small landholdings, low productivity, lack of mechanization, and climate change. However, the Indian government and private sector are actively working towards overcoming these challenges and promoting sustainable agriculture practices in the country.

Fertigation in Modern Agriculture

Fertigation is a modern agricultural practice that involves the application of fertilizers through irrigation systems. It has had a significance.

1. Increased efficiency in fertilizer application: Fertigation allows farmers to apply fertilizers precisely and in controlled amounts. This results in better nutrient uptake by crops and less wastage of fertilizers.

2. Improved crop yields: The precise application of fertilizers through fertigation has led to increased crop yields in modern agriculture. This is because crops receive the right amount of nutrients at the right time, resulting in optimal growth and development.

3. Reduced water usage: Fertigation reduces water usage in modern agriculture. This is because nutrients are delivered directly to the plant roots, reducing the amount of water needed to transport the nutrients.

4. Reduced soil erosion: Fertigation reduces soil erosion in modern agriculture. This is because the application of fertilizers through irrigation systems reduces the need for mechanical soil preparation, which can lead to soil erosion.

5. Improved environmental sustainability: Fertigation has contributed to the sustainability of modern agriculture by reducing the use of chemical fertilizers, which can have negative environmental impacts. The precise application of fertilizers through fertigation also reduces the amount of nutrients that leach into groundwater or other water bodies, reducing the risk of pollution.

Overall, fertigation has had a positive impact on modern agriculture by increasing efficiency, improving crop yields, reducing water usage, reducing soil erosion, and improving environmental sustainability.

Conclusion

In conclusion, fertigation has had a significant impact on modern agriculture. The precise application of fertilizers through irrigation systems has improved crop yields, reduced the risk of over-fertilization, minimized wastage, and reduced the use of chemical fertilizers. Fertigation has also led to a reduction in water usage, soil erosion, and the need for mechanical soil preparation, promoting environmental sustainability in modern agriculture.

The adoption of fertigation has also led to increased efficiency in modern agriculture. Farmers can apply fertilizers in controlled amounts, improving the nutrient uptake of crops and reducing the time and labor required for manual fertilization. This has led to cost savings for farmers and increased profits.

Overall, fertigation has become an essential part of modern agriculture, contributing to sustainable agriculture practices and the growth of the agricultural sector. As technology continues to advance, it is expected that the use of fertigation and other modern agricultural practices will further increase, leading to even greater benefits for farmers, the environment, and society as a whole.

Potential and Affordability of Micro-Irrigation Systems in Sustainable Agriculture

Article ID: 40682

Aastha Thakur[1], Dr. Yadvendra Pal Singh[1]
[1]School of Agriculture, Lovely Professional University, Punjab.

Introduction

Micro-irrigation is a modern irrigation technique that provides control over the amount and timing of water delivered to the plants. It distributes water slowly and efficiently to specific locations near to the root zone of the plants. This method can be ideal for the areas where water resources are limited, helping to conserve water and reduce runoff. Micro-irrigation systems can be customized to different types of crops, soil conditions, and planting pattern to make it a versatile and effective method for agricultural and horticultural applications. This technology is one of the most important components in sustainable agriculture practice. This promotes optimal plant growth while minimizing water wastage.

This technique involves providing water to plants through small emitters or drippers, which deliver water at a slow rate directly to the root zone of the plants. The principle behind micro-irrigation is to provide the necessary amount of water to the plants over a time of period in a highly efficient and controlled way. With this technique, plants can receive optimum moisture levels, leading to better growth and better quality of yield.

Micro-Irrigation Technologies

It refers to a set of methods use of low-pressure water delivery systems and are designed to minimize water wastage at the same time improving plant growth and yield. Micro-irrigation technologies include:

1. Drip Irrigation: This is the most commonly used micro-irrigation technology. It involves delivering water slowly to the roots of plants through a network of tubes or pipes that have small perforations.

2. Micro-sprinklers: Micro-sprinklers deliver water in a fine mist, which is more efficient than traditional sprinklers. They are best suited for larger plants and areas with higher water requirements.

3. Subsurface Irrigation: In subsurface irrigation, water is delivered directly to the root zone through buried tubes or pipes. This technology avoids surface evaporation losses and is ideal for areas with high water scarcity.

4. Root Zone Watering: With root zone watering, water is delivered directly to the root zone of the plant using specially designed containers or porous pipes.

Overall, micro-irrigation technologies are increasingly being adopted by farmers globally due to their ability to save water and improve crop yields.

Advantages of Micro-Irrigation

1. Water Conservation: Micro-irrigation systems deliver water directly to plant roots, minimizing water use by up to 70% compared to traditional irrigation methods and the percentage increases as we talk about drip irrigation system to 99%.

2. Improved Plant Growth and quality of produce: Micro-irrigation systems can help improve plant growth by providing consistent and precise amounts of water and nutrients directly to the root zone, leading to better crop yields and quality. This way water logging is not possible which reduces the chances of disease spread for better quality of produce.

3. Reduced Soil Erosion: By delivering water directly to the root zone, micro-irrigation systems can help reduce soil erosion caused by runoff due to heavy flow of water.

4. Energy Savings: Micro-irrigation systems require less energy than traditional irrigation systems because they operate on low pressure and flow rates.

5. Reduced Labor: Micro-irrigation systems are automated and require less labor for installation, operation, and maintenance, saving time and money.

6. Improved Water Quality: Traditional method of irrigation provides heavy flow of water leading runoff of fertilizer and pesticide leaching, and upper layer of soil. This leads to contamination of water.

7. Reduced Weed Growth: Micro-irrigation systems deliver water only where it is needed, reducing the spread of weeds and unwanted vegetation in surrounding areas.

8. Versatility: Micro-irrigation systems can be used in a variety of applications, including agricultural, fertigation in agriculture and horticulture, commercial, and residential landscaping, and can be customized to fit any size or shape of land.

Disadvantages of Micro-Irrigation

1. Initial investment: Micro irrigation systems can be costly to install, which can be a barrier for some farmers and gardeners who have a limited budget to invest in irrigation setup.

2. Maintenance: Micro irrigation systems require regular maintenance, including cleaning the filters and ensuring that the system is functioning properly, which can be time-consuming and labor-intensive. The small emitters used in micro irrigation systems are prone to clogging, which can cause uneven water distribution and reduce the effectiveness of the system.

3. Weather conditions: Micro irrigation systems are highly sensitive to changes in weather conditions, such as wind and temperature, which can impact their performance.

4. Sustainability: Some critics argue that micro irrigation systems are not sustainable because they rely on a constant supply of water, which is not always available or affordable in arid regions.

5. Limited coverage: Micro irrigation systems are typically designed for small areas and may not be practical or cost-effective for large-scale farming operations.

6. Soil compaction: Micro irrigation systems can contribute to soil compaction, which can lead to reduced soil health and crop yields over.

Affordability

Affordability of micro-irrigation systems depends on various factors such as the size and type of the system, materials used, installation costs, and maintenance expenses. Generally, micro-irrigation systems are more expensive than conventional irrigation methods.

However, they also offer significant advantages such as higher efficiency and water savings, which can lead to reduced operating costs in the long run. Furthermore, some governments and organizations offer subsidies or financial assistance for the installation of micro-irrigation systems, making them more affordable for farmers and other users.

Overall, the affordability of micro-irrigation depends on individual circumstances and needs, but it is important to consider the long-term benefits and cost savings when making a decision.

Micro-Irrigation Potential in India

It has a vast potential for micro-irrigation due to its large irrigated area and the need to conserve water resources. According to the Ministry of Agriculture and Farmers' Welfare, the potential for micro-irrigation in India is estimated to be around 69 million hectares.

However, the adoption of micro-irrigation in India has been slow. As per government data, only 11.83 million hectares have been covered under micro-irrigation till March 2020, which is less than 18 percent of the potential area.

The government of India has launched several schemes and initiatives to promote micro-irrigation in the country. Under the Pradhan Mantri Krishi Sinchai Yojana (PMKSY), a flagship program of the government, there is a provision for 100 percent funding for small and marginal farmers and 60%funding for other farmers for installation of micro-irrigation systems.

The government has also set up a National Mission on Micro Irrigation (NMMI) to promote the adoption of micro-irrigation in the country. Under this mission, financial assistance is provided to the farmers for the installation of micro-irrigation systems.

In 2019, the government announced a target of covering an additional 10 million hectares under micro-irrigation by 2021-22.

Overall, the potential for micro-irrigation in India is huge, and with the government's efforts to promote its adoption, it is expected to see significant growth in the coming years.

There are many different low-cost micro-irrigation systems available, and careful consideration should be given to factors such as soil type, climate, and crop type before selecting the best system for a specific situation.

Trench irrigation: In this system, shallow trenches are dug around the plants to deliver water directly to the roots.

Micro-sprinkler irrigation: This system involves installing small sprinklers throughout the field to provide targeted watering to the plants.

Subsurface irrigation: This system involves burying pipes or tubing underground to deliver water directly to the roots of plants.

Wicking beds: This system involves using a raised garden bed with a wicking layer of material at the bottom to draw water up from a reservoir below, providing consistent moisture to the plants.

Conclusion

Micro-irrigation systems have the potential to revolutionize agriculture by providing precise control and efficient use of water resources. While there are still some challenges to be overcome, such as initial installation cost and maintenance issues, the benefits of micro-irrigation outweigh these concerns. Micro-irrigation systems conserve water, reduce soil erosion, increase crop yields, and decrease the use of fertilizers and pesticides. Moreover, the integration of alternative energy sources, such as solar power, further enhances the sustainability of these systems. Therefore, policymakers, farmers, and water resource managers must work together to promote the adoption of sustainable micro-irrigation systems for a greener future.

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Soil Fertility and Plant Nutrition

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Mrudula. P[1], Dr Yadvendra Pal Singh[1]
[1]Lovely Professional University, School of Agriculture, Phagwara, Punjab.

Abstract

Plant nutrition and soil fertility are crucial components in ensuring the healthy growth and productivity of plants. A review article on this topic would likely provide an overview of the various essential nutrients required by plants and their roles in plant growth and development. It would also explore the factors that contribute to soil fertility, such as organic matter content, pH, and nutrient availability. The article includes different methods used to assess soil fertility and plant nutrient status, such as soil and plant tissue analysis, as well as various techniques for improving soil fertility, such as organic matter amendment and the use of fertilizers. The challenges and limitations of managing soil fertility in different agro-ecosystems, such as issues related to soil degradation, nutrient leaching, and the negative impacts of intensive agricultural practices on soil health. The article would emphasize the importance of a balanced and sustainable approach to plant nutrition and soil fertility management for ensuring food security and preserving the health of agro-ecosystems.

Introduction

Plants are the cornerstone of life on earth, providing essential food and oxygen to sustain the ecosystem. The growth and productivity of plants are heavily influenced by the availability of nutrients in the soil. Soil fertility, therefore, plays a crucial role in ensuring the health and productivity of crops, and is an essential aspect of sustainable agriculture and horticulture practices. The study of plant nutrition and soil fertility has a long history, with a focus on understanding the essential macronutrients, such as nitrogen (N), phosphorus (P), and potassium (K), and micronutrients, such as iron (Fe), zinc (Zn), and copper (Cu), that plants require for growth and development. In addition, soil organic matter, pH, and other physical and chemical properties of the soil also play a crucial role in plant growth and productivity. Despite the importance of soil fertility for plant growth and productivity, many soils are depleted of essential nutrients due to factors such as poor management practices, over-farming, and land degradation. The increasing demand for food and biofuels is putting additional pressure on soil resources, leading to soil degradation and nutrient depletion in many regions. In this review article, provide the current state of knowledge on plant nutrition and soil fertility, including the essential nutrients required by plants, the role of soil organic matter and pH, and the impact of soil degradation on plant growth and productivity. We will also examine various approaches for improving soil fertility and plant nutrition, including the use of organic and inorganic fertilizers, crop rotation, and cover crops. By understanding the complex relationship between plant nutrition and soil fertility, we can develop sustainable agriculture and horticulture practices that support the growth of healthy and productive plants and help ensure food security.

Current State of Knowledge on Plant Nutrition and Soil Fertility

The study of plant nutrition and soil fertility has a long history and has advanced significantly over the years. The current state of knowledge on plant nutrition and soil fertility is extensive and multi-disciplinary, drawing on fields such as agronomy, soil science, plant physiology, and environmental science.

Macronutrients: It is well established that plants require a range of macronutrients for growth and development. The three essential macronutrients are nitrogen (N), phosphorus (P), and potassium (K). N is required for the synthesis of proteins and chlorophyll, P is involved in energy transfer and storage, and K is essential for water balance and the regulation of stomata. A lack of any of these macronutrients can limit plant growth and reduce crop yields.

Micronutrients: In addition to macronutrients, plants also require a range of micronutrients for growth and development. The most common micronutrient deficiencies in crops include iron (Fe), zinc (Zn), and copper (Cu). Fe is involved in photosynthesis and the production of chlorophyll, Zn is essential for growth and reproduction, and Cu is required for enzyme activity and disease resistance.

Soil Organic Matter: Soil organic matter plays a critical role in soil fertility, as it provides a source of essential nutrients for plants and improves soil structure and water-holding capacity. In addition, soil organic matter is involved in the cycling of nutrients, helping to conserve soil nutrients and reduce the loss of nutrients through leaching.

Soil pH: Soil pH is another important aspect of soil fertility, as it affects the availability of essential nutrients to plants. Most crops grow best in soils with a pH range of 6 to 7, as this range provides optimal availability of essential nutrients. A soil pH that is too low or too high can limit the availability of essential nutrients to plants and reduce crop yields. (Jones jr).

Soil Degradation: Despite the importance of soil fertility for plant growth and productivity, many soils are depleted of essential nutrients due to factors such as poor management practices, over-farming, and land degradation. Soil degradation is a major problem in many regions, leading to declining soil fertility and reduced crop yields. Climate change, deforestation, and other environmental stressors are also contributing to soil degradation, further exacerbating the problem. The current state of knowledge on plant nutrition and soil fertility highlights the importance of understanding the complex relationship between plants and their soil environment. Further research is needed to better understand the factors that contribute to soil fertility, and to develop sustainable agriculture and horticulture practices that support the growth of healthy and productive plants. (Bindra ban).

Approaches for Improving Soil Fertility and Plant Nutrition, Including

Crop rotation: This involves rotating crops in a field to ensure that soil nutrients are not depleted by continuous cultivation of the same crop in the same area.

Fertilization: This involves adding nutrients to the soil through the use of chemical fertilizers or organic matter such as compost, manure, and green manures.

Soil amendment: This involves adding organic matter to the soil to improve its structure and fertility. This can be done by adding compost, manure, or other organic matter to the soil.

Liming: This involves adding lime to the soil to increase its pH, which can help to make nutrients more available to plants.

Irrigation: Proper irrigation can help to ensure that plants receive the water and nutrients they need for healthy growth.

Cover cropping: This involves planting a crop that will add organic matter and nutrients to the soil when it is tilled under.

Intercropping: This involves planting multiple crops in the same field, which can help to increase the overall productivity of the land and reduce the depletion of soil nutrients.

Proper tillage: This involves using appropriate tillage practices to minimize soil erosion and maintain soil structure.

Microbial inoculation: This involves adding beneficial microbes to the soil to improve soil fertility and plant health.

Nutrient-dense varieties: Planting nutrient-dense crop varieties that are bred to have higher levels of essential nutrients can also help to improve soil fertility and plant nutrition.

By implementing these approaches, it is possible to improve soil fertility and plant nutrition, leading to healthier crops and higher yields.

Complex Relationship Between Plant Nutrition and Soil Fertility

The relationship between plant nutrition and soil fertility is complex and interdependent. Soil fertility provides the necessary nutrients and growing conditions for plants, while plants contribute to maintaining and improving soil fertility. Soil fertility is a measure of the ability of a soil to provide the necessary nutrients for plant growth and is determined by several factors, including soil pH, nutrient availability, organic matter content, and soil structure. These factors affect the uptake of nutrients by plants, which can impact their growth, yield, and overall health on the other hand, plants also play an important role in maintaining and improving soil fertility. As plants grow, they take up nutrients from the soil and return organic matter and nutrients to the soil when they die and decompose. This organic matter serves as a natural fertilizer, adding important nutrients to the soil and improving its structure. In addition, certain plant species have the ability to fix atmospheric nitrogen and add it to the soil, providing a valuable source of nitrogen for other plants. This process is known as biological nitrogen fixation. The relationship between plant nutrition and soil fertility is therefore a reciprocal one, where the health and productivity of plants depend on the fertility of the soil, and the fertility of the soil depends on the health and productivity of plants. Proper soil management and the use of soil-friendly farming practices, such as crop rotation, fertilization, and the addition of organic matter, can help to maintain and improve soil fertility, which in turn will support the growth and health of plants. (McGrath).

Develop Sustainable Agriculture and Horticulture Practices that Support the Growth of Healthy Productive Plants and Ensure Food Security

Crop rotation: This involves rotating crops in a field to ensure that soil nutrients are not depleted by continuous cultivation of the same crop in the same area.

Integrated pest management (IPM): This involves using a combination of approaches, such as biological control, cultural practices, and selective use of pesticides, to manage pests and diseases in an environmentally responsible manner**.**

Conservation tillage: This involves minimizing soil disturbance during planting, which can help to reduce erosion and maintain soil structure, while also providing habitat for beneficial insects and other organisms**.**

Cover cropping: This involves planting a crop that will add organic matter and nutrients to the soil when it is tilled under.

Intercropping: This involves planting multiple crops in the same field, which can help to increase the overall productivity of the land and reduce the depletion of soil nutrients.

Organic farming: This involves avoiding the use of synthetic fertilizers and pesticides and instead relying on natural processes and inputs, such as compost and green manures, to support plant growth and fertility**.**

Water management: This involves using efficient irrigation systems and implementing water-saving practices to conserve water and reduce the impact of agriculture on water resources.

Soil health management: This involves promoting the health and productivity of soil by using practices such as cover cropping, composting, and minimizing tillage.

Methods Used to Assess Soil Fertility and Plant Nutrient Status

Soil Analysis: Soil samples are collected from various locations within a field and analyzed in a laboratory to determine the levels of essential plant nutrients such as nitrogen, phosphorus, and potassium, as well as micronutrients such as iron, zinc, and manganese. Soil analysis can also provide information on soil pH, organic matter content, and the availability of other important nutrients**.**

Plant Tissue Analysis: Samples of leaves, stems, or roots are collected from plants and analyzed to determine the levels of essential nutrients. This method can help to identify nutrient deficiencies or excesses and is useful for diagnosing specific problems with plant growth.

Remote Sensing: The use of aerial imagery or satellite data can provide a quick and non-destructive assessment of plant growth and health. For example, the normal color and chlorophyll content of healthy leaves can be used to detect nutrient deficiencies or imbalances.

Visual Assessment: Visual symptoms of nutrient deficiencies or excesses can be used to assess plant nutrient status. For example, yellowing of leaves can indicate a nitrogen deficiency, while stunted growth can indicate a lack of phosphorus**.**

Yield Monitoring: Crop yields can provide an indirect assessment of soil fertility and plant nutrient status. Low yields can indicate soil fertility problems, while high yields can indicate adequate soil fertility and plant nutrition.

Challenges and Limitations of Managing Soil Fertility in Different Agro Eco Systems

Soil Degradation: Intensive agricultural practices can lead to soil degradation, which can reduce soil fertility and limit crop productivity. Soil degradation can occur due to over-tilling, overgrazing, and the loss of organic matter due to improper land management practices.

Nutrient Leaching: The application of excess fertilizers can result in the leaching of nutrients from the soil, which can contaminate groundwater and surface water. This can lead to environmental degradation and health problems**.**

Soil Acidity: Soil acidity can limit the availability of essential plant nutrients, leading to reduced crop productivity. Acid soils can occur naturally, or they can be the result of human activities such as the application of acidifying fertilizers or the use of acidic irrigation water.

Limitations of Fertilizers: Fertilizers can provide essential plant nutrients, but their application can also have negative impacts on soil health, such as reducing soil organic matter and promoting soil erosion. Fertilizer costs can also be high, making them unaffordable for many small-scale farmers**.**

Lack of Knowledge: Many farmers lack the knowledge and resources necessary to properly manage soil fertility, which can result in poor soil health and reduced crop yields. This is particularly true for small-scale farmers in developing countries who may not have access to information about best practices for soil fertility management.

Conclusion

Soil fertility and plant nutrition are critical components of sustainable agriculture and horticulture. A healthy, fertile soil provides the necessary nutrients and growing conditions for plants to grow and thrive, while plants contribute to maintaining and improving soil fertility. To ensure the growth of healthy, productive plants and ensure food security, it is important to implement sustainable agriculture and horticulture practices that promote soil fertility and plant nutrition. These practices include crop rotation, integrated pest management, conservation tillage, cover cropping, intercropping, organic farming, water management, and soil health management. The relationship between soil fertility and plant nutrition is complex and interdependent, and requires a holistic approach to soil management to ensure long-term sustainability. With the right management practices in place, it is possible to maintain and improve soil fertility, while also supporting the growth and health of plants. soil fertility and plant nutrition are key components of sustainable agriculture and horticulture and play a critical role in ensuring food security and the growth of healthy, productive plants. Implementing appropriate management practices and promoting soil fertility and plant nutrition is essential for a sustainable and thriving agricultural system.

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Impact Study on Mushroom Cultivation through Training Programme and its Processed Food for Entrepreneurship Development and Women Empowerment in Chhattisgarh

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Chetna Jangde[1], Dr. Subuhi Nishad[1]
[1]Mushroom Research Laboratory, Department of Plant Pathology, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India, 492012.

Abstract
Mushrooms are delicious, edible, nutrition rich and generate employment in between small and marginal farmers. This report discusses about the training programmes of mushroom cultivation to make farmers self-employed including womens as well as surveyed data of mushroom rural growers. Different training was conducted in different regions of Chhattisgarh in session 2022-23. Total 16 training programmes were conducted minimum of 01 day and maximum of 08 days. Here 08 days training was conducted in Raipur, Chhattisgarh. Another survey shows that maximum growers are found in rural areas to be mens as compared to women. Potassium constitutes the major fraction of major elements followed by sodium and calcium.

Keywords- Mushrooms, farmers, self-employed, training programmes.

Introduction
Edible mushroom is considered as one of the important food sources. Oyster, paddy straw and milky mushrooms are grown seasonally in the tropical/sub-tropical areas from April to October. The present production of white button mushroom is about 85% of the total production of mushrooms in the country. Mushrooms are medicinally important too as it have important role in some diseases to suppress its growth and development like cancer as well HIV. Mushrooms are nutritionally rich in protein and vitamins.

Material and Methods
Spawn Production Technology: Spawn, i.e. seed required for growing mushroom, is the vegetative mycelium from a selected mushroom cultured on a convenient medium like wheat, pearl millet, sorghum grains, etc. In simple words spawn is grains covered with mushroom mycelium.

Procedure for Oyester mushroom production:
1. Take 10 kg of wheat straw.
2. Treat the straw with Bavistin 4gm, Formalin 125 gm and processed lime 100 gm for protection from fungal disease.
3. Treat 60 litre capacity container with 4 drops Formalin.
4. Mix the 10 kg wheat straw in 45 litre water in a 60 litre capacity container.
5. Take 100 gm spawn and put it around in a layer.
6. Same procedure is applied at least 4-5 layer.
7. After filling of spawn pack the polythene and 15-20 holes done in polythene for air circulation.
8. Take the bag in a dark room which is treated with 2 litre water and 100 gm Formalin. The bags are kept for 4 days in a dark room, not allowing light to pass through the close room.
9. After 25 days first production coming, harvesting is done by hand.
10. Then remove the plastic and treat with water and 100 gm of bleaching powder.
11. After treatment again take the polythene in a dark room.
12. After 7 days of first production, we can take it for second production.
13. After 13 days of second production, we can take it for third production.
14. We can get 12-18 kg production of mushroom from this method.

Results and Discussion

Different training was conducted in different regions of Chhattisgarh in session 2022-23. Total 16 training programmes were conducted minimum of 01 day and maximum of 08 days. Here 08 days training was conducted in Raipur, Chhattisgarh given in table 01.

Table 01- Different Training Programmes collected data of Session 2022-23 of Chhattisgarh:

Training Place	Date	Duration	Rural Men Participated	Rural Womens Participated	Total
Gariyaband, Chhattisgrah	10-01-2022 to 14-01-2022	05 days	11	2	13
Mahasamund, Chhattisgrah	14-02-2022	01 day	11	3	14
Raipur, Chhattisgrah	21-02-2022 to 28-02-2022	08 days	17	13	30
Gariyaband, Chhattisgrah	07-03-2022 to 10-03-2022	04 days	0	60	60
Charoda, Chhattisgrah	09-03-2022 to 16-03-2022	8 days	3	53	56
Bhatgaon, Chhattisgrah	21-03-2022 to 23-03-2022	03 days	0	31	31
Raipur, Chhattisgrah	27-05-2022	01 days	1	2	3
Raipur, Chhattisgrah	24-06-2022	01 days	3	3	6
Raipur, Chhattisgrah	26-08-2022	01 days	5	0	5
Raipur, Chhattisgrah	23-09-2022	01 days	7	2	9
Keshkal, Chhattisgrah	06-11-2022 to 11-11-2022	6 days	5	33	37
Raipur, Chhattisgrah	25-11-2022	01 days	12	0	12
Raipur, Chhattisgrah	25-11-2022	01 days	5	29	34
Chirchari-Balod, Chhattisgarh	12-12-2022 to 14-12-2022	3 days	7	79	86
Raipur, Chhattisgrah	24-02-2023	01 days	17	10	27
Gariyaband, Chhattisgrah	01-03-2023 to	03 days	0	60	60

	03-03-2023				

Table 2- Percentage of Male and female in Training programmes:

S. No.	Categories	Numbers	Percent (%)
1.	Male (20-60 Year)	104	21.5%
2.	Female (20-60 Year)	380	78.5 %

This table 2 shows that highest number of females were participated in the training programmes which shows that females are more interested to generated mushroom self-employment as compared to men.

Table 3- List of Rural mushroom growers surveyed near Raipur and Bilaspur districts of Chhattisgarh:

Women Growers	Place of farm	Men growers	Place of farm
Pooja shukla	Dhatrenga	Hemlal sahu	Kurud
Namrata yadu	Raipur	Dhurwendra	Raipur
Beltukdi mushroom farm	Rajim	Devi Prasad	Gatora
Tejashwi mushroom	Kurud	Arjun Kumar	Urtun
Mahila samooh	Arang Raipur	Dharam Shrivas	Limtara
Thakur mushroom farm	Charoda	Anil Patel	Ratanpur
Sita SHG	Vedparsada	Uttam Patel	Sarkanda
Maa Durga SHG	Banyadih	Dev Kumar	Nawagaon
Gaura gauri SHG	Vedparsada	Sehdev Dhuri	Takhatpur
Sita Dubey	Ratanpur	Arun Prajapati	Sendri
Suman Loria	Lormi	Durgesh Vastrakar	Chakarbhata
		Ateeth Pathak	Bilaspur
		Ajay Pande	Takhatpur
		Neeraj Pande	Bilaspur
		Deendayal Yadav	Baharadeeh
		Ramadhar Dewangan	Seoni
		Ravindra Singh	Patharia

This table 3 is a surveyed data of mushroom growers of rural areas and also Self-Help Groups. In which maximum growers are found to be men as compare to women.

Table 4- Paddy straw mushroom Nutrition profile used for making processed mushroom food:

Nutrition	quantity/100 fresh mushroom
Moisture	90.30 (g)
Fat	0.35 (g)
Protein	3.80 (g)
Crude fibre	1.77 (g)
Ash	1.50 (g)
Phosphorus	0.20 (g)
Potassium	0.32 (g)
Iron	1.60 (g)
Calcium	5.00 (mg)
Thiamine	0.12 (mg)
Riboflavin	0.62 (mg)
Niacin	2.20 (mg)
Ascorbic acid	17.00 (mg)

There are several benefits including medicinal purposes that accrue from the chemical and nutritional composition of oyster mushroom spp. Oyster mushrooms are rich in protein (29%), dietary fiber (13%), vitamins and minerals, and have no cholesterol **(Tolera 2017).**

Conclusion

Scope of mushroom production in Chhattisgarh is very broad. But due to technology gap among farmers it was found that they are not interested in mushroom cultivation. During survey, many good suggestions was given to farmers to increase cultivation of mushroom as well as use of different agricultural waste management through mushroom cultivation.

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Terrarium

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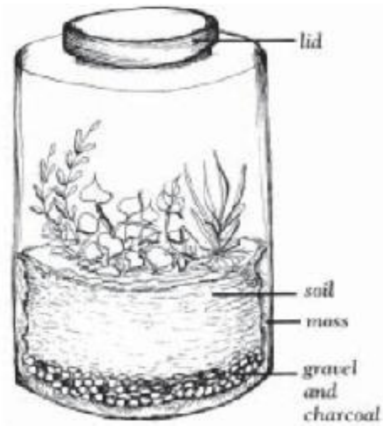
Ardra. A[1]
[1]B. Sc (Hons), Agriculture, S. Thangapazham Agricultural College, Vasudevanallur, Tenkasi.

Introduction

Interior decoration of house with plants and miniature landscaping is granting popularity these days when most of the people do not have open space in their houses. Some special features of gardening play a very important role to develop attractive- mini-garden inside a house. These special features are known as "Terrarium". A terrarium is a collection of plants growing in a glass-enclosed container.

Materials Needed

1. Containers
2. Soil
3. Potting media
4. Fertilizer(optional)
5. Drainage material
6. Plants
7. Accessories.



Container

Select a container of clear, colorless glass or plastic._Select a container of clear, colorless glass or plastic. Avoid translucent or colored glass or plastic, as it will limit the quantity and quality of light available for photosynthesis by the plants inside. Aquariums, gallon-size jars, spheres, decorative containers, and pop bottles are readily available and easy to transform into terrariums.

Soil

Enough soil is needed to make a 1½-inch to 2-inch layer in the bottom of the container. The soil should be porous to allow good drainage. It should be slightly moist for planting.

Potting Media

Growing media consist of potting mixture (1:1:1:1 ration of soil: sand: Farm Yard Manure: cocopeat), charcoal and pebbles.

Drainage Material

Terrarium has no drainage holes as that of your outdoor pots, Provision must be made for the escape of excess water. A layer of moss on the bottom of the terrarium can serve as a drainage layer in very small containers. For large containers Broken pieces of clay flower pots or charcoal, or a layer of sand or fine gravel may be added before the moss layer.

Plants

Ferns, Peperomia, Air plants, Foliage, Moss, Bromeliads, Orchids.



Peperomia Moss Orchids

Accessories

Rocks, gravel, sticks, wood, seedpods and bark provide pleasing accessories to terrariums. Ceramic figures of frogs, mushrooms, snails can provide natural setting.

Types of Terraria

1. Closed terrarium
2. Open terrarium.

Closed Terrarium: Closed terrariums are sealed shut with a lid or cork and it create a unique environment for plant growth, as the transparent walls allow for both heat and light to enter the terrarium.

Open Terrarium: Terrarium can also be open to the atmosphere rather than being sealed. Open terrariums have access to fresh air, most commonly through the opening of the glass container.


Open Terrarium Closed Terrarium

Planning and Designing

The largest plants among the selected ones can be planted in the middle of the glass container, and then the smaller ones can be planted around. Decorative items, moss, shells, pebbles or rocks of different size and colours can also be added make terrarium attractive.

Tools

1. Trowel
2. Spoon
3. Tongs
4. Rammer
5. Fork cum Rake.

Climate for Terrarium

The terrarium requires, warm-filtered sun light.

Care and Maintenance

1. Never overwater. Excess water is almost impossible to remove. Better a little too dry than too wet.
2. Keep the terrarium out of direct sun light but make sure that it is good in indirect light
3. Pruning often promote side- shoot growth that fills out plants.
4. Terrarium need to be cleaned regularly to remove build ups of condensation or algae from the inside surface of the glass. This can be easily done using a small sponge attached to a bamboo stalk.
5. Plants in terrariums should not grow rapidly, terrarium seldom need fertilizer. Do not fertilize for at least a year after planting.

Conclusion

Terrariums are most useful for small plants that do not adapt well to normal home atmospheres. When properly planted and located, they provide a novel way to grow many plants with minimal care.

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How Important Cholesterol in Eggs?

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Abasaheb K. Parade[1], Pranjali B. Meshram[1], Chetan C. Chougale[1]
[1]Ph.D Research Scholar, Department of Animal Husbandry and Dairy Science,
Mahatma Phule Krishi Vidyapeeth Rahuri-413722, Ahmednagar (MH).

During the 1990s there was a drastic decline in egg consumption in the developed world. This was due to concerns about the high cholesterol content of eggs, which stemmed from the perceived effects of cholesterol on coronary heart disease (CHD). In fact blood cholesterol level ranks only about fourth or fifth in the risk factors for CHD. Smoking, excessive bodyweight, lack of exercise, hypertension and stress are other important factors, but publicity about the unproven effects of dietary cholesterol on CHD had a major impact on the sale of cholesterol-rich foods, particularly eggs, even though it has been shown that dietary factors may account for only 25 percent of all causes of elevated blood cholesterol (Narahari, 2003). A 60-g egg contains about 200 mg of cholesterol. The standard daily recommended maximum intake of cholesterol is 300 mg.

Important Facts about Cholesterol

There are two not widely known facts: i) cholesterol must be in the oxidized (rancid) form to cause the arterial plaques that lead to partial blockage of the blood vessels; and ii) some forms of cholesterol are beneficial. High-density lipoprotein cholesterol (HDL) protects against heart disease by mopping up circulating cholesterol. The culprit is the low-density lipoprotein cholesterol (LDL) in the oxidized form that narrows or "hardens" the arteries. One way of counteracting this process is therefore to eat foods rich in natural antioxidants. A third important point is that the fat in eggs is in the unusual form of emulsified oil, almost half of which is made up of healthy monounsaturated fats. This combination probably minimizes the effect of eggs on blood cholesterol. Cholesterol is not a dietary requirement although it is found in almost every cell in the body, particularly in the brain and nervous tissue. The liver produces up to 2 000 mg per day. Only about 50 percent of dietary cholesterol is absorbed, while the rest is excreted.

Individuals may Respond Differently to Dietary Cholesterol Not Everyone Responds to Dietary Cholesterol

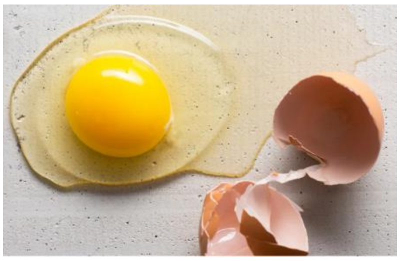
There are hypo- and hyper-responders (85 and 15 percent of the population respectively). In one experiment (Elkin, 2006), men and women were given 21 eggs per person per week, amounting to about 640 mg of cholesterol per day. Plasma LDL did not change in the hyporesponders; in the hyper-responder group it increased by a small but statistically significant amount (10 to 15 mg/dL). Given the unrealistically high consumption of eggs in this study (three per day), it is surprising that the hypo-responder group did not also show an increase in LDL cholesterol.

Reducing Blood Cholesterol with Drugs

Statins are a group of drugs that inhibit the enzyme HMG-CoA reductase from converting HMG-CoA into mevalonate – an early step in the synthesis of cholesterol. Given the very wide functions of cholesterol, this could be thought to be a retrograde step, but apparently it is not. Consequently, statins frequently account for a very large share of drug sales, as they are routinely prescribed even for people with only mildly elevated cholesterol, who then often stay on them for life.

Can Egg Cholesterol be Reduced?

Attempts have been made to lower the cholesterol in eggs (Elkin, 2007) by feeding different grains to layers, which may reduce egg cholesterol by about 10 percent. Feeding copper at 125 or 250 parts per million (ppm) can reduce cholesterol in eggs by up to 31 percent. Feeding garlic as a paste at up to 8 percent of the diet may reduce egg cholesterol by as much as 24 percent, but there is wide variation. Other natural products have also shown significant but inconsistent responses. Genetic selection for low and high egg cholesterol has met with little success. Although the cholesterol content of the egg is well in excess of that needed for embryo development, reducing egg cholesterol beyond a certain point can decrease hatchability and/or egg production.



Drainage Material

Terrarium has no drainage holes as that of your outdoor pots, Provision must be made for the escape of excess water. A layer of moss on the bottom of the terrarium can serve as a drainage layer in very small containers. For large containers Broken pieces of clay flower pots or charcoal, or a layer of sand or fine gravel may be added before the moss layer.

Can we Reduce Absorption of Cholesterol in Food?

Excess cholesterol is removed from the liver as HDL cholesterol, or largely converted into bile salts, then passed into the ileum, absorbed back into the blood stream and returned to the liver. Some continues to the colon and is excreted as bile acids. Compounds such as insoluble dietary fibre and saponins, found in plants (especially the yucca tree), can bind cholesterol in the small intestine, causing it to be excreted. Fibre also increases the rate of food passage, thereby reducing the opportunity to recycle cholesterol via the lower ileum.

The yolk cholesterol levels can be significantly reduced by supplementing herbal plants and products like basil (tulsi), bay leaves, citrus pulp (nirangenin), grape seed pulp guar gum, roselle seeds, spirulina, tomato pomace (lycopene),and many more herbs in chicken diets will reduce the chicken and yolk fat cholesterol levels by 10-25%.

The poultry industry is well aware of the cholesterol health issues. Product quality and safety have always been of primary importance. In fact, research interest in the poultry industry has continued to deal with quantification and reduction of cholesterol in eggs so that a low-cholesterol product will be available to those consumers who need to lower their dietary cholesterol intake. Designer eggs containing lower cholesterol and saturated fat concentrations are available to the general public The poultry industry has continually strived to supply the consumer with the highest quality fresh and processed product.

During the last 20 years the egg industry has been under intense attack by anti-cholesterol advocates. The egg has been blamed, blasted and defamed as one of the major culprits in coronary heart disease (CHD). Several studies have indicated that supplementation with dietary micro minerals copper, chromium, zinc, vanadium, and iodine or dietary vitamins (vitamin A, ascorbic acid, and niacin) may change the yolk cholesterol level. Supplementation of natural products like garlic, probiolac and Lactobacillus acidophilus in poultry feed help to reduce egg yolk cholesterol. A large egg contains about 213 mg of cholesterol per yolk.

How many Eggs should we Eat?

Nearly half (45 percent) of the public in the India still believe that they should be eating a maximum of three eggs a week. A recent article in the British Nutrition Foundation's Nutrition Bulletin (2009, 34(1): 66–70) reveals those misconceptions about eggs and cholesterol stem largely from incorrect conclusions drawn from early research. Many heart and lung health organizations have done a complete turn-about and some have even given eggs the "heart tick" of approval. Although the recommendation of 300 mg of cho-lesterol per day as the upper level still stands, there is general consensus that one egg a day will do no harm – not that the cholesterol content of the egg has changed in the meantime. Many nutrition and health advisory bodies may have been influenced by several recent scientific papers, which have dispelled myths around eggs and cholesterol. Australian, Canadian and Irish heart foundations and the British Nutrition Foundation have raised their guideline limits in accordance with recent findings that there is no conclusive evidence to link egg consumption with an increased risk of heart disease.

Public Perception of Eggs is Difficult to Change

Concern about a link between cholesterol in eggs and risk factors for heart disease is difficult to dispel. Many people living in developing countries still believe in the dangers of eating eggs, even though they would be the least at risk. Except for the few most affluent people, the staple diet in developing countries is mainly plant-based and contains only small amounts of cholesterol.

Conclusions

Consumption of one egg per day will have no effect on blood cholesterol; recent research suggests that two per day will also have no significant effect for most of the population. The conclusion is that eggs are not detrimental to human health and that for those in low- income countries, eggs are very important for good health and well-being, and their consumption should be encouraged.

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Nutritional Labelling

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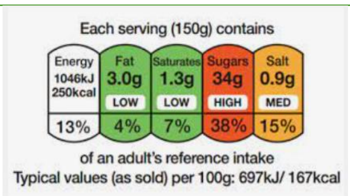
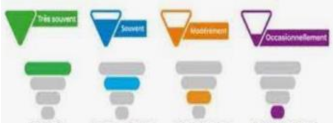
Surbhi Nagdev[1], Ritu Nagdev[2]
[1]Research Analyst, Aranca, Gurugram, Haryana.
[2]Scientist, ICAR-National Bureau of Soil Survey and Land Use Planning (NBSS & LUP), Regional Centre, New Delhi.

Nutrition labelling is a description which is intended to inform the consumer about nutritional properties of a food product. It is usually represented at Front of the package thus also known as FoP label. The use of nutritional labels is rising day by day due to the increased awareness and eagerness of consumers to understand the food they're consuming. It also plays a good role by restricting companies to do misleading or deceptive advertising.

Below are some common nutritional labels used all over the world.

Label	Jurisdiction	Description
	India	**Fortified Logo:** Food Safety and Standards Authority of India has addressed the issue of micronutrient deficiencies in October 2016. It operationalized the Food Safety and Standards (Fortification of Foods) Regulations, 2016. It is for fortifying staples such as Wheat Flour and Rice (with Iron, Vitamin B12 and Folic Acid), Milk and Edible Oil (with Vitamins A and D) and Salt (with Iodine and Iron) to reduce the high burden of micronutrient malnutrition in India. Such food contains the logo of food fortification.
	India	**Trans-Fat Free Logo:**Trans-fat is a type of unhealthy fat that increases the risk of heart disease and stroke. In order to increase the awareness about the risk associated with trans-fat FSSAI (Food Safety and Standards Authority of India) has launched 'Trans-fat Free' logo. This logo can be used on foods containing 0.2 grams of trans-fat per 100 grams of food.
	Europe	**Nutri-Score Label:** The Nutri-Score label is also known as the 5-Colour Nutrition label or 5-CNL. It depicts the nutritional level of food in five colours from green being the best to red being the worst. It is an attempt to simplify the nutritional rating system demonstrating the overall nutritional value of food products. The algorithm is based on giving scores to both healthy and unhealthy ingredients and subtracting them. Lowest the value healthier will be the food.
	Australia	**Low GI Logo:** The GI (Glycemic Index) on food is the indication that the food has a low speed of increasing the blood glucose levels after consumption.

	Australia	**Health Star Rating:** This front-of-pack labelling food logo used in Australia is a voluntary logo. The rating ranges from ½ a star to 5 stars.The greater number of stars is a healthier choice. For example - All GI Symbol products have a 3.5-star rating or higher.The Health Star Rating is based on the nutrient profile of the food per 100g or mL.
	USA	**NuVal Logo:** This system is based on grocery stores. It is based on a custom algorithm created by a group of nutrition and public health specialists; foods are rated from 1 to 100. Regardless of portion size, the approach divides a food's positive nutrient score by its negative nutrient score to produce a final number between 1 and 100. Foods with higher scores are more nutrient-dense.
	Norway, Denmark and Sweden	**Keyhole Logo:** This logo is another voluntary label. It indicates that the food contains one or more of these requirements – • More dietary fibre • Less saturated fat • Less salt • Less sugar
	Poland, Czech Republic, Netherlands	**The choices logo:** It is also known as Vinkje logo. It is used as a front-of-pack logo for food and beverage products. It takes into account the amount of saturated fatty acids, trans fatty acids, added sugars, salt, and fibre, as compared with similar products within the category. Therefore, by looking at the logo one can make a mindful choice regarding the consumption of food.
	Finland	**Heart Symbol Log:** This logo is used in Finland. It identifies options with a better nutrient profile that are a healthier choice for heart. It can be used on foods that contains less saturated fats, trans-fats etc.
	Chile, Uruguay and Peru	**Uruguay's Front-of-Pack Warning Label:** This front of packaging label has been introduced for food from March 1, 2020. It is for products that contains excess level of sugar, salt, fat and saturated fat. It exempts products such as table sweetener, foods for special diet or medical purposes, infant foods etc.
	Italy	**Nutrinform Battery Logo:** This system provides the amount of energy, saturated fats, sugars and salt for a portion of food and the percentage that these represent in relation to the average reference intakes for an adult. This amount is represented in the form of batteries.

	Thailand	**Healthier Choice Logo:** This logo is used in Thailand. It indicates that the food products that are low in sugar, fat, and sodium.
	Singapore	**Healthier Choice Logo:** This is a Singaporean label. It represents the main feature of the food by representing different healthier choice taglines appropriate to food. Each product will carry the tagline appropriate to the product as long as the nutritional guidelines have been satisfied.
	USA	**Great For You:** It is used on foods in Walmart stores. The logo is an indication that the food is good for health. It is used on foods that are fresh and non-processed and even if processed have lower amounts of unhealthy ingredients such as sugar, trans-fats, excess sodium etc.
	United Kingdom	**Traffic Light Logo:** This logo indicates that how muchsaturated fats, sugar and salt are in that particular food.Red light indicates that the food contains high levels of unhealthy ingredients, similarly amber colour indicates medium levels of unhealthy ingredients and lowest level of unhealthy fats or absence of unhealthy fats are indicated by green.
	France	**SENS Label (Simplified Nutritional Labelling System):** It is a nutritional label of France. It contains four colours green, blue, amber and purple. Green-labelled foods indicates that they be eaten 'often', blue 'from time to time', amber 'in moderation' and purple 'occasionally, or in small quantities'.

Conclusion

Nutritional labelling aids in making an informed choice. It has the potential to affect the lifestyle in a healthy manner. A healthy population is an asset for any nation. That is why recently, FSSAI (Food Safety and Standards Authority of India) has also launched logo for fortification, trans fats etc. This practice will also affect the competition in market for better products leading to a good environment for markets and consumer in general.

It has been observed generally that the existing nutritional labels are targeting the information regarding only sugar, salt and unhealthy fats. The way forward can be targeting other ingredients for various target groups. The target groups can include lactose, gluten, nuts intolerant people etc.

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Role of Enzymes in Pathogenesis

Article ID: 40688

Dr K Saravanakumari[1]
[1]Senior Research Fellow, Department of Plant Pathology, Tamil Nadu Agricultural University, Tamil Nadu – 641 003.

Introduction

Plant-pathogenic fungi produce an array of extracellular hydrolytic enzymes that enable them to penetrate and infect the host tissue; these enzymes are collectively called Cell Wall-Degrading Enzymes (CWDE). They may contribute to pathogenesis by degrading wax, cuticle and cell walls, thus aiding tissue invasion and pathogen dissemination. Furthermore, they can act as elicitors of host defense reaction.

The Structure of Plant Cell Walls

During the initial association with their hosts, plant pathogens encounter epicuticular waxes and cuticle covering host epidermal cell. Epicuticular wax consists of a relatively soluble complex mixture of long-chain fatty acids, aldehydes, alkanes, primary and secondary alcohols, ketones and wax esters, whereas the cuticle is a continuous layer of lipid material that consists of insoluble polymeric material called cutin. This cuticular matrix also decreases the vulnerability of plants to pathogen attacks by providing both mechanical disease resistance and cellular signals for resistance responses.

The plant cell wall is one of the major barriers that protect plants against pathogens. It plays a crucial role in apoplastic diffusion of water and ions, and protects the internal protoplast. Cell walls comprise a middle lamella, the outermost part of the wall, shared by adjacent cells. A primary wall laid down internally to the middle lamella, and when cell enlargement ceases a secondary wall may form. The cell wall contains predominantly cellulose, matrix materials, and water. Cellulose, a major component of the primary and secondary wall layers, is a straight-chain polymer of glucose (β-1,4-glucan). Groups of 100 to 10,000 cellulose molecules are covalently linked with hydrogen bonds to form microfibrils. Within the microfibrils, the crystalline areas are called micelles while the rest of the regions are paracrystalline. Matrix materials are composed of pectic substances, hemicelluloses, and structural proteins. These amorphous materials are distributed between the cellulose microfibrils. Pectic substances constitute the main components of the middle lamella and also make up a large portion of the primary cell wall of young plant cell, in which they form an amorphous gel filling the spaces between the cellulose microfibrils. Pectin is a family of complex and highly heterogeneous polysaccharides, the pectin backbones mainly consist of α-1.4-linked-D-galacturonic acid residues that form homogalacturonan chains. The side chains of this backbone structure contain L-rhamnose, arabinose, galactose and xylose. Cell walls also contain a variety of proteins, such as glycoprotein and extensin. Glycoprotein is a complex of sugars and proteins and these proteins are characterized by abundant hydroxyproline and proline amino acids on the wall.

Cell Wall Degrading Enzymes

Pectinases have proved to be quite important for the infection of various phytopathogenic fungi. Pectic enzymes produce modification of cell wall structure, increasing accessibility of cell wall components for degradation by other enzymes, cell lysis and plant tissue maceration. Pectic enzymes (in multiple forms) are the first polysaccharidases to be induced when fungi are cultured on isolated plant cell walls and the first produced in infected tissue. Enzyme gold and immuno-gold labelling techniques, that *F. culmorum* and *F. graminearum* produced CWDE such as cellulases, xylanases and pectinases at early stages of infection in wheat spikes, observing alterations of cell wall components in the infected host tissue. These studies suggest that cell wall-degrading enzymes produced by this phytopathogen facilitate rapid colonization of wheat spikes.

Classification of Pectinases

Pectinases are classified under three headings according to the following criteria: pectin, pectic acid or oligo D-galacturonate is the preferred substrate, whether pectinases act by trans-elimination or hydrolysis and whether the cleavage is at random (endo-, liquefying of depolymerizing enzymes) or endwise (exo- or saccharifying enzymes).

Esterases: pectin methyl esterase catalyzes the de-esterification of pectin by removal of methoxy esters. Depolymerases: catalyze the cleavage of the α-(1,4)- glycosidic bonds in the D-galacturonic acid moieties of the pectic substances.

Role of Pectinases in Pathogenesis

Though pectin does not seem to be the most recalcitrant cell wall component, the pectin degrading enzymes have proved to be decisive in the infection process, so long as pectin degradation results in weakening of cell walls, leading to penetration of fungi. Generally, fungal pathogens secrete various extracellular enzymes and may be involved in virulence. Positive effects were shown for pectinolytic enzymes from *Aspergillus flavus*, *Botrytis cinerea* and *Claviceps purpurea*. The disruption of genes encoding these enzymes resulted in the reduction of virulence in the respective fungi. The precise role of most other extracellular enzymes is still controversial. In most studied cases correlations were observed between the presence of pectic enzymes, disease symptom and relative virulence. An interesting example is observed in *B. cinerea*, where the endo-polygalacturonase (PG) activity is regulated by atleast 5 endo-PG genes, and the deletion of only one endo-PG gene reduced virulence on tomato. The expression on transgenic plants of a PG inhibitory protein resulted in a considerable reduction of virulence of *B. cinerea*. Similar reduction of virulence was measured with PG mutants from *B. cinerea* on wild-type tomato. The heterologous expression of a pectate lyase from *Colletotrichum gloeosprioides* in *Colletotrichum magna* led to increase virulence of transformants on watermelon. In *C. purpurea* replacement of two closely linked PG genes resulted in a sharp reduction of pathogenicity on rye, but the disruption of other CWDE genes (celluloses, xylanases) did not have effect on virulence significantly. On the other hand, a double mutant of *C. carbonum* lacking the two major extracellular PGs (having less than 1% of total wild-type PG activity) displayed normal virulence on maize.

Conclusion

Evidence for the need of plant CWDEs for attack by plant-pathogenic fungi on their hosts can be deduced from differences in the enzyme arsenal between saprophytic and plant-pathogenic fungi, as well as between plant-pathogenic fungi that utilize different modes of pathogenesis. However, functional evidence for the essentiality of CWDEs in virulence has been reported for only some enzymes (particularly those involved in pectin/pectate depolymerization). In addition, some of the transcription factors that regulate expression of genes encoding CWDEs have been identified and have further supported the critical role of these enzymes in plant pathogenesis. The present evidence suggests that there is no general mechanism that can explain the behavior of all plant pathogenic fungi, but significant differences in the importance of specific CWDEs or CWDE families are evident even between species from the same genus.

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Decision Support System (DSS)

Article ID: 40689

Anjali Tomar[1], Rahul Dhankar[2]
[1]Ph.D. Scholar, Department of Agriculture Extension and Communication, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh.
[2]Assistant Professor, Shri Vishwakarma Skill University, Palwal, Haryana.

Introduction

Decision Support System (DSS) is a computer-based application that collects, organizes and analyzes business data to facilitate quality business decision making for management operations and planning.

DSS is playing a key role in managing business enterprise through making right choice at right time. It is an integral part of Modern Agricultural Management that helps to identify correct enterprise, correct stake holder, proper market destination thereby saving money, time & cost. Decision making is thus a process of selecting the right choice at the right time from the basket.

DSS is an outcome of Management Information System (MIS), providing support for management at operational control, management control, and strategic planning. Management activity of each of these classes includes planning, control, and decision making.

Definition

Decision Support System (DSS) is a specific class of computerized information system that supports decision-making activities. The emphasis is on 'support' rather than on automation of decision.

In 1984, Freyenfeld (1984) proposed the following empirical definition of DSS based on discussions with some 30-supplier user and academic organization:
1. A Decision support system is an interactive data processing and display system which is used to assist in a concurrent decision-making process, and which also confirm to following characteristics:
2. It is sufficiently user- friendly to be used by decision makers(s) in person;
3. It displays its information in a format and terminology which is familiar to the user(s); and
4. It is selective in its provision of information and avoids its user(s) in information overload."

Characteristics of DSS

1. Facilitation – DSS facilitates and supports specific decision-making activities or decision processes.
2. Interaction – DSS are computer-based systems designed for interactive use by decision makers or staff users who control the sequence of interaction and the operations performed.
3. Ancillary – DSS can support decision makers at any level in an organization. They are not intended to replace decision makers.
4. Repeated use – DSS are intended for repeated use. A specific DSS may be used routinely or used as needed for adhoc decision tasks.

Need For DSS

1. Fast computation
2. Enhanced productivity
3. Better decision
4. Data transmission.

Functions of DSS

There are five basic functions of a DSS facilitating managerial decision making-
1. Model building - It allows decision makers to identify the most appropriate model for solving the problem at hand. It takes in to account input variables, interrelationships among the variables, problem assumptions and constraints.

2. What-if analysis - It is the process of assessing the impact of changes to model variables, the values of the variables, or the interrelationships among variables.
3. Goal seeking - It is the process of determining the input values required to achieve a certain goal.
4. Risk analysis - It is a function of DSS that allows managers to assess the risks associated with various alternatives.
5. Graphical analysis - It helps managers to quickly digest large volumes of data and visualise the impact of various courses of action.

Components of DSS

Decision support systems consist of three main components namely, database, software system and user interface.
1. DSS Database: It contains data from various sources, including internal data from the organization, the data generated by different applications, and the external data mined form the Internet, etc.
2. DSS Software System: It consists of various mathematical and analytical models that are used to analyse the complex data, thereby producing the required information.
3. DSS User Interface: It is an interactive graphical interface which makes the interaction easier between the DSS and its users. It displays the results (output) of the analysis in various forms, such as text, table, charts or graphics. The user can select the appropriate option to view the output according to his requirement.

Advantages of DSS

1. Time savings- For all categories of decision support systems, research has demonstrated and substantiated reduced decision cycle time, increased employee productivity and more timely information for decision making.
2. Enhance effectiveness- A second category of advantage that has been widely discussed and examined is improved decision-making effectiveness and better decisions.
3. Improve interpersonal communication- DSS can improve communication and collaboration among decision makers. In appropriate circumstances, communications driven and group DSS have had this impact.
4. Cost reduction- Some researches and especially case studies have documented DSS cost saving from labour savings in making decisions and from lower infrastructure or technology costs.
5. Promote learning- Learning can occur as a by-product of initial and ongoing use of a DSS. Two types of learning seem to occur: learning of new concepts and the development of a better factual understanding of the business and decision-making environment.

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Mitigation of Terminal Heat Stress by Using Different Bioregulators in Wheat

Article ID: 40690

Pattam Keerthi[1]
[1]Department of Agronomy, College of Agriculture, CCS Haryana Agricultural University, Hisar 125001.

Introduction

According to the Intergovernmental Panel on Climate change (IPCC, 2021) concentrations of GHG have continued to increase in the atmosphere. It also shows that emissions of GHGs from human activities are responsible for approximately 1.1°C of warming since 1850-1900. For 1.5°C of global warming, there will be increasing heat waves, longer warm season and shorter cold seasons. At 2°C of global warming, heat extremes would more often reach critical tolerance thresholds for agriculture and health**.** Temperature controls the rate of metabolic processes of the plant that ultimately influence the production of biomass (Hay and Walker, 1989). High temperature stress is a major environmental stress that limits crop growth, metabolism and productivity worldwide. Thus, in the changing climatic scenarios, there is a need to reinvent the research strategies i.e., adaptations of resource conservation technologies, judicious use of available water resources, enhance value-added weather management services and also to moderate the stresses due to biotic and abiotic factors to mitigate the deleterious effects of climate change (Buttar et al., 2012). It was further suggested to find out new strategies for ameliorating high temperatures stress in wheat in South East Asia and Southern Africa.

Terminal heat stress: High temperature stress during reproductive development termed as terminal heat stress. It is suggested that optimal temperature for grain set and grain filling is between 19 °C and 22 °C in wheat (Porter and Gawith, 1999). During the grain filling period, heat stress can accelerate leaf senescence and affect final grain weight by shortening the grain filling duration. Lobell et al. (2005) reported that wheat yield in Mexico decreased by 10% for every 1 °C increase in night time temperature and grain yield showed a strong negative correlation with increasing minimum temperature. There are two typical heat stresses are common during wheat grain filling. “Heat shock” is characterized by sudden, extreme high temperatures (>32 °C) for a short duration (3-5 days), while “chronic heat stress” consists of moderately high maximum temperatures (20-30 °C) for a longer duration. High temperature during wheat reproductive development hastened the decline in photosynthesis and leaf area, decreased shoot and grain mass as well as weight and sugar content of kernels.

Impact of Terminal Heat Stress on Plant System

Heat stress can induce oxidative stress along with tissue dehydration. Generation and reactions of ROS, that is, singlet oxygen, superoxide radical (O_2^{-}), hydrogen peroxide (H_2O_2), and hydroxyl radical (•OH) are common events during cellular injury by high temperature (Liu and Huang, 2000). It has been suggested that photosynthesis II (PSII) was inhibited during heat stress, which is the most thermally liable component of the electron transport chain, it also resulted in disruption in the structure and function of chloroplasts and reduction in chlorophyll content.

The reduction in the optimum growth period caused by increased temperature leads to early leaf senescence resulting in low photosynthesis rate (Sharma-Natu et al., 2010). Shortage of assimilate during grain filling further reduces number of grains spike^{-1} and grain weight. As heat stress causes reduced photosynthesis; it also, thus lowers leaf water potential. Stressed plants attempted to combat the effect of high temperature by increasing their transpiration.

In many temperate cereal crops, both grain weight and grain number appear to be impacted by heat stress, with a decline in grain number directly proportional with increasing temperatures during flowering and grain filling (Mahmood et al., 2010). For example, increase of just 1 °C temperature above 15–20 °C at grain filling stage can reduce grain weight by 1.5 mg per day. Although elevated temperatures promote the growth, it reduces the phenological duration of various crop stages, which is not compensated by the enhanced growth rate.

Heat stress shortens the grain filling duration but accelerates the grain filling rate (Dias and Lidon, 2009). Male sterility as a consequence of heat stress can be widely observed among many crop plants and the impairment of pollen development has been the main factor involved in reduced yield under heat stress (Wassmann et al., 2009) Heat stress also reduces carbohydrate accumulation in pollen grains and in the stigmatic tissue by altering assimilate partitioning and changing the balance between symplastic and apoplastic loading of the phloem.

Role of Osmoprotectants /Bio Regulators to Mitigate Terminal Heat Stress

Osmoprotectants has potential to increase food production and quality much more quickly than plant breeding techniques.

1. *Ascorbic acid* (Vitamin C) is water soluble and acts as a modulator of plant development through hormone signaling and as coenzyme in reactions by which carbohydrates and proteins are metabolized. They also regulate photosynthesis flowering and senescence (Barth et al., 2006).

2. Cytokinins are important group of plant bioregualators which play important role in greater partitioning of photosynthates towards reproductive sink thereby improving the harvest index. Exogenous application of Moringa leaf extract, rich in cytokinin, ascorbic acid, phenol and K leads to an increase in wheat grain yield, more stable cell membrane and longer seasonal leaf area duration (Yashmeen et al., 2011)

3. The exogenous applications of **nitric oxide donor** (NO) confer tolerance to various stresses. It also causes higher water retention and less transpiration rate. In wheat, exogenous application of **Sodium Nitro prusside (SNP)** accelerated protein synthesis, enhanced photosynthesis rate and maintained higher relative water content in wheat seedlings under drought stress (Tan et al., 2008). *Foliar application of N* during reproductive phase may be due to better distribution and consistent availability of nitrogen to the plant throughout the crop season, which helped the plants to grow better and continuous supply of nitrogen to the grains during its development.

4. Foliar spray of **thiourea** improved net photosynthesis, chlorophyll content and nitrogen metabolism in drought stressed dusting leading to improvement in seed yield (Garg et al., 2006)

5. Potassium (K+) act as osmoregulator during stress for increased active update of K^+ by the guard cells and stomatal regulation. Exogeneous application of K^+ was required to maintain photosynthetic ability in wheat during heat stress (Premchandra et al., 1993) Spray of *0.2% potassium chloride* means 400 g of MOP in 200 lit of water for every one acre is suggested. Kaur et al. (2011) also concluded that four foliar sprays of 2% potassium nitrate solution starting from flowering at weekly interval are needed to obtain the highest seed cotton yield.

6. Calcium plays an essential role in processes that preserve the structural and functional integrity of plant membranes, stabilize cell wall structures, regulate ion transport and selectivity, and control ion-exchange behaviour as well as cell wall enzyme activities.

7. Exogenous application of 0.5 mm **salicylic acid** alleviated heat stress in wheat by increasing proline production through the increase in y-gletamyl kinase and decrease in proline oxidize activity resulting in promotion of osmotic potential and water potential necessary for maintaining photosynthetic activity. (Khan et al. 2013)

8. Zinc may have a role in modulating free radicals and their related damaging effects by enhancing plant's antioxidant systems (Zago and Oteiza, 2001). Silicon under heat or drought stress maintains plant water balance, photosynthetic efficiency and erectness of leaves and structure of xylem vessels under high transpiration rate (Hattori et al., 2005). It increases the number and mass grain production of wheat by stimulating shoot and root biomass (Filho et al., 2005) under water stressed conditions.

8. Plant-growth-promoting rhizobacteria (PGPR) mitigate the impact of heat stress on plants through the production of exopolysaccharates and biofilm formation. PGPR mitigate the impact of drought on plants through a process so-called induced systemic tolerance (IST), which includes: a) bacterial production of cytokinins b) production of antioxidants and c) degradation of the ethylene precursor ACC by bacterial ACC deaminase.

Conclusion

Heat stress results in the production of reactive oxygen species which causes cellular damage, hinders photosynthesis and altered metabolic activities, result in poor crop yield. In recent years, exogenous application of osmoprotectants has shown improvement in growth and yield of wheat under terminal heat stress. However, field experiments that combine different biochemical, molecular and agronomic management practices are needed to investigate further their roles in ameliorating adverse effects of high temperature stress on final grain yield of wheat

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Paruthi Paal: A Nutritious and Delicious Beverage with Health Benefits

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Ananda Lekshmi L[1], Bhimireddy Sukrutha[1], Banoth Madhu[1]
[1]Department of Plant Breeding and Genetics, TNAU, Coimbatore Tamil Nadu, India.

Introduction

Paruthi Paal, also known as cotton nutrient milk, is a traditional beverage from Tamil Nadu, a southern state in India. It is made by boiling cotton seeds in water and adding milk, sugar, and cardamom for flavor. The resulting drink is a creamy and nutritious beverage that has been enjoyed by people in the region for generations. Historically, cotton seeds were considered waste material in the textile industry. However, people in Tamil Nadu discovered that cotton seeds had great nutritional value and could be used to make a delicious and nutritious beverage. Cotton seeds are rich in protein, fiber, and minerals like calcium, iron, and phosphorus. Paruthi Paal was traditionally consumed by farmers and laborers who needed a filling and energizing drink to sustain them during their long workdays.

In recent years, Paruthi Paal has gained popularity beyond Tamil Nadu and has become a trendy health drink in other parts of India and even internationally. The beverage is known for its numerous health benefits, including boosting immunity, aiding digestion, and promoting bone health. One of the unique characteristics of Paruthi Paal is its versatility. The beverage can be enjoyed hot or cold, and it can be customized to suit individual tastes. Some people prefer to add saffron, nuts, or other spices to enhance the flavor of the drink.

Nutritional Benefits of Paruthi Paal

Paruthi Paal is a nutrient-dense beverage that provides several health benefits due to its rich nutritional profile. Cotton seeds are a good source of protein, fiber, and minerals like calcium, iron, and phosphorus. Milk, which is added to Paruthi Paal, is also a good source of protein and calcium. Here are some of the nutritional benefits of Paruthi Paal:

1. Boosts Immunity: Paruthi Paal contains antioxidants that help to boost the immune system and protect the body against disease and infection.

2. Promotes Digestion: The fiber in Paruthi Paal helps to regulate digestion and prevent constipation.

3. Good for Bone Health: Calcium and phosphorus in Paruthi Paal help to strengthen bones and prevent bone-related diseases like osteoporosis.

4. Energizes the Body: The protein in Paruthi Paal provides sustained energy, making it an ideal beverage for people who need a quick pick-me-up during the day.

Possible Side Effects of Paruthi Paal

While Paruthi Paal is generally safe to consume, it may not be suitable for everyone. Here are some of the possible side effects of Paruthi Paal:

1. Allergic Reactions: Some people may be allergic to cotton seeds or other ingredients in Paruthi Paal. If you experience any symptoms like itching, hives, or difficulty breathing after consuming Paruthi Paal, stop drinking it immediately and seek medical attention.

2. High in Calories: Paruthi Paal is high in calories due to the sugar and milk content, so it should be consumed in moderation, especially if you are trying to lose weight.

3. High in Fat: The milk in Paruthi Paal is high in fat, so it may not be suitable for people with high cholesterol or heart disease.

4. Digestive Issues: Some people may experience digestive issues like bloating or diarrhea after consuming Paruthi Paal, especially if they are not used to consuming high-fiber foods.

Making Paruthi Paal is a simple process that can be done at home. It needs the following ingredients, 1 cup cotton seeds, 4 cups water, 1 cup milk, 1/4 cup sugar and 1/4 tsp cardamom powder.

Instructions

1. Rinse the cotton seeds and remove any dirt or debris.
2. In a large pot, add the cotton seeds and water and bring them to a boil.
3. Reduce the heat and simmer for about 30 minutes, or until the cotton seeds are soft and tender.
4. Strain the mixture through a fine-mesh sieve to separate the liquid from the solids.
5. Return the liquid to the pot and add the milk, sugar, and cardamom powder.
6. Stir well and bring to a boil.
7. Reduce the heat and simmer for another 10 minutes.
8. Serve hot or cold, garnished with nuts or saffron if desired.

In conclusion, Paruthi Paal is a nutritious and delicious beverage with a rich history and numerous health benefits. If you're looking for a unique and healthy drink to add to your diet, give Paruthi Paal a try.

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Reverse Breeding Technique

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Ananda Lekshmi L[1]
[1]Department of Plant Breeding and Genetics, TNAU, Coimbatore Tamil Nadu, India.

Reverse breeding is a novel plant breeding technique that involves generating progeny with parental genotypes in their homozygous state. This technique, which was first developed in 2009, has the potential to revolutionize plant breeding by accelerating the development of new plant varieties with desirable traits. Traditional plant breeding involves crossing two parental lines and selecting offspring with desired traits, which can take years or even decades to achieve. However, reverse breeding simplifies this process by first generating a haploid plant with the same genetic makeup as one of the parental lines. This haploid plant can then be used to generate homozygous offspring, which are identical to the original parental line.

Reverse breeding is achieved through the use of genome editing techniques, such as CRISPR-Cas, to knock out specific genes in the haploid plant. This results in a plant that is unable to produce viable gametes, and therefore cannot reproduce sexually. However, the haploid plant can still be propagated vegetatively, allowing the homozygous offspring to be generated.

One of the main advantages of reverse breeding is that it can significantly reduce the time and resources required to develop new plant varieties. Traditional plant breeding can take many years of crossing and selection, but with reverse breeding, homozygous progeny can be generated in just a few generations. This can help to accelerate the development of new plant varieties with desirable traits, such as improved yield, resistance to pests and diseases, and increased nutritional content. Another advantage of reverse breeding is that it allows for the preservation of rare and endangered plant species. By generating homozygous offspring from a single plant, reverse breeding can help to maintain the genetic diversity of rare and endangered plant populations, which can be important for conservation efforts.

However, there are also potential limitations and concerns associated with reverse breeding. One concern is that the use of genome editing techniques to generate haploid plants may be viewed as genetically modified organisms (GMOs), which could face regulatory challenges. Additionally, the use of reverse breeding may limit the genetic diversity of offspring, as all progeny will have the same genotype as one of the parental lines.

Reverse breeding is a plant breeding technique that involves generating offspring with parental genotypes in their homozygous state. The steps involved in the reverse breeding technique are as follows:

1. Selection of parental lines: The first step in reverse breeding is the selection of two parental lines with desirable traits. These parental lines should be genetically divergent to ensure maximum genetic variation in the offspring.

2. Generation of haploid plants: Haploid plants are plants that contain only one set of chromosomes instead of the usual two sets. To generate haploid plants, the selected parental line is treated with a chemical mutagen or subjected to irradiation to induce mutations. This results in the formation of haploid cells through a process called gametic embryogenesis.

3. Genome editing: The next step in reverse breeding is to edit the genome of the haploid plant using genome editing techniques such as CRISPR-Cas. The goal of genome editing is to knock out specific genes that are responsible for the production of viable gametes. This results in a plant that is unable to reproduce sexually.

4. Propagation of haploid plants: The haploid plants are propagated vegetatively by tissue culture techniques to generate homozygous progeny. Since the haploid plant cannot produce viable gametes, the homozygous progeny will have the same genetic makeup as the original parental line.

5. Selection of homozygous progeny: The homozygous progeny are selected based on the desired traits and are further propagated to generate pure homozygous lines.

6. Crosses between homozygous lines: The pure homozygous lines are crossed to generate hybrids with desired traits. This results in the production of offspring with the same genetic makeup as the original parental lines.

Overall, the reverse breeding technique can significantly accelerate the development of new plant varieties with desirable traits. It simplifies the breeding process by generating homozygous progeny in just a few generations, and it can also help to preserve rare and endangered plant species. However, the use of genome editing techniques may be viewed as genetically modified organisms, which could face regulatory challenges.

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Millets, Types and Biofortification Approaches

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J. M. Rajalakshmi[1], M Nirmal Bharathi[2], Karibasappa C S[3], D. Kannan[4], J. M. Samraj[5]

[1]Assistant Professor, Department of Plant Breeding and Genetics, Palar Agriculture College, Kothamarikuppam, Tamil Nadu, India-635805.

[2]Assistant Professor, Department of Agricultural Biotechnology, Palar Agriculture College, Kothamarikuppam, Tamil Nadu, India-635805.

[3]Assistant Professor, Department of Plant Pathology, Palar Agriculture College, Kothamarikuppam, Tamil Nadu, India-635805.

[4]Assistant Professor, Department of Horticulture (Vegetable science), Palar Agriculture College, Kothamarikuppam, Tamil Nadu, India-635805.

[5]Assistant Professor, Department of Entomology, Palar Agriculture College, Kothamarikuppam, Tamil Nadu, India-635805.

Introduction

Millets are unrefined seeds that are grown and harvested in the Indian subcontinent for the last 7000 years. They are small-grained seeds that grow with the proper temperature and fertile ground. They include high nutritional value and are rich in proteins, vitamins, minerals, and fibers. Unlike other cereals, millets demand little water and ground fertility. They possess long appreciated the tag of "poor man's food grain" due to its fine affordability.

Millets are important crops in the semiarid tropics of Asia and Africa, with 97% of millet production in developing countries. This crop is favoured due to its productivity and short growing season under dry, high-temperature conditions. The agricultural sector has induced the need for the increased production of millets due to their affordability and nutrient quality in human beings

Millets don't put stress on our already-declining water supplies because they are widely grown as rain-fed crops. Every year, high-quality products are made with these millets, which are highly nutritious. Such millets are popular because they are simple to manage and keep.

History of Millets

Little millet is considered to have been domesticated around 5000 years ago in India and Kodo millet around 3700 years before in India. Different millets have been introduced in some of the Yajurveda texts, identifying foxtail millet (priyaṅgu), Barnyard millet (aṇu) and black finger millet (śyāmāka), indicating that millet agriculture was occurring around 1200 BCE in India.

Types of Millets in India

Naked grains: Naked grains are three common types that are without the hard, indigestible husk that some millets possess. Specifically, such millet categories include, Ragi, Jowar, and Bajra. These millets don't demand processing after harvest. They can directly be utilized after being washed.

Husked grains: The second kind of millets is the Kodo millet, Foxtail millets and Little millets. These varieties have an indigestible seed coat. The husk on them needs to be separated prior they are fit for consumption. Millets include a multitude of micronutrients such as iron. Also, they take time to digest, which doesn't cause the blood sugar spike associated with easily digestible food.

Millets with Tamil Name & Source are Listed Below:

1. Pearl Millet is a huge source of proteins, it is recognized as Bajra
2. Barnyard Millet is a great source of iron and fiber. It is recognized as Kuthiravali in Tamil
3. Finger Millet is a staple that is a substitute for oats and cereals. It is known as Ragi in Kannada, Kelvaragu in Tamil.
4. Foxtail Millet is abundant in minerals and vitamins. It is known as Thinai in Tamil.
5. Little Millet is also packed with iron and fibre, the local names are Samai in Tamil.

6. Proso Millet is recognized as Panivaragu in Tamil.

Health Benefits of Millets

1. Anti-acidic
2. Gluten-free
3. Detoxify body
4. Help lower cholesterol
5. Prevents breast cancer and many other diseases
6. Prevent type 2 diabetes
7. Reduce blood pressure
8. Protection against heart diseases
9. Helps in treating respiratory conditions like asthma
10. Optimize kidney, liver and immune system health
11. Reduces risk of gastrointestinal conditions
12. Helps in avoiding issues like constipation, excess gas, bloating.

Biofortification in Millets

Biofortification in millets can be achieved through two strategies:
1. By enhancing the accumulation of nutrients in milled grains and
2. By reducing the antinutrients to increase the bioavailability of minerals.

Biofortification Breeding Approach

The pearl millet biofortification breeding program at ICRISAT has taken a three-pronged breeding phase-I, II and III. The first phase is a short-term approach dealing with traits genetics, germplasm screening and creating genetic variability. The second phase is the medium-term approach consisting of validating identified high-iron and zinc breeding lines and hybrid parents from the regular breeding program to develop fast-track biofortified variety/hybrids. The third phase consisted of long-term objective-development high-Fe/Zn breeding lines and hybrid parents and its genetic diversification through steady mainstreaming micronutrient traits at ICRISAT and NARS breeding programs. In brief, these micronutrients are largely governed by additive genes; thus, biofortification breeding approaches are the same as for as any other quantitative traits. Previous reports also indicate the greater importance of additive gene action for grain Fe and Zn in pearl millet. The heritability of these micronutrients was very high and not much influenced by the environments. The pedigree breeding method is a most common method in pearl millet breeding which deals entirely with the progenies derived from bi-parental crosses, and this method is well described by Andrews et al. This method also utilizes composites as a base population that has the potential to accelerate the genetic gains for the yield in hybrids and widen the genetic base of hybrid-parents and cultivars. However, composites will be used for pedigree breeding of hybrid parents only when they fulfil the basic traits required of hybrid parents. Pearl millet has different cytoplasmic sterility systems (CMS); however, A1, A4, and A5 are widely used. The adoption of cytoplasmic genetic male sterility falls under the standard three-line system (A, B, and R) to produce a hybrid seed. Currently, A1 and A4 are exploited under the commercial breeding programs in India. All the pearl millet hybrids so far developed in India are based on A1 CMS, while the biofortification program uses both A1 and A4 CMS to diversify the new cultivar base. Currently, the pearl millet biofortification is in a gradual transition from fast-track breeding (breeding phase II) to genetic diversification and mainstreaming (breeding phase III). The development of biofortified fast-track hybrids/varieties at ICRISAT is briefly described in Figure 1. Currently ICRISAT demonstrated the combining micronutrients and grain yield by conventional breeding approaches. The fast-track approach explained in Figure 1 uses existing moderate to higher Fe/Zn content breeding lines and a population that is not bred for the micronutrient content. Breeding parental lines (seed- and restorer-parents) bred for high Fe density as a target trait will address the long-term objective of breeding hybrids, despite high-Fe levels. In this direction, 174 high-Fe early-generation progenies (B × B progenies and R × R progenies) have been developed, which in trials conducted at Patancheru had shown > 90 mg kg−1 Fe density and 36 to 72 mg kg−1 Zn density. Based on a preliminary study, the identified common and overlapping Quantitative Trait Loci (QTL) for Fe and Zn densities are in LG3 (chromosome 3) Consequently, the substantial variation for Fe and Zn is available in elite breeding populations, and more emphasis is required on developing diagnostic makers for screening segregating materials in the future.

Characterization of Millet Germplasm for Grain Nutrients

Conservation of plant genetic resources (PGRs) provides a continuous supply of raw material for crop improvement. Success of biofortification program lies in the sustainable utilization of PGRs for nutritional enhancement (Muthamilarasan and Prasad, 2015). International Crop Research Institute for Semi-Arid Tropics (ICRISAT) contains the largest collection of millet germplasm representing 27.4% of total crop accessions in the gene bank of this, pearl millet constitutes the vast majority of germplasm represented by 23,092 accessions including landraces, cultivars, genetic stocks, breeding lines, and wild relatives. Finger millet germplasm consisting of 6,084 accessions is grouped under two subspecies, africana and coracana on the basis of morphology of inflorescence. Foxtail millet is a self-fertilizing species including 1,542 accessions from 23 different countries. Barnyard millet germplasm comprises of 749 accessions mainly from Japan and India.The major collections of kodo millet from India and USA account for 665 accessions. India is the prime contributor of little millet germplasm with 473 accessions (Upadhyaya et al., 2016c). Despite holding the largest millet germplasm, scientific community from India has made very few attempts to utilize the millet genomic resources for biofortification. This is mainly because of the scarcity of information on germplasm characterization for nutritional traits.

Achievements

Under the biofortification program, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and Mahatma Phule Krishi Vidyapeeth jointly developed a high-iron variety of pearl millet, called Dhanashakti, which was released in 2012 in Maharashtra and later in 2013 across India, making it the first.

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Broiler Goat Rearing

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Pranjali B. Meshram[1], Abasaheb K. Parade[1], Akshay P. Chawke[1]
[1]Ph.D Research Scholar, Department of Animal Husbandry and Dairy Science, Mahatma Phule Krushi Vidyapeeth Rahuri. 413722, Ahmednagar (MH).

Goat Rearing is one of the highly demanded businesses in the world. We already in a situation where open grazing lands are decreasing and drought areas where the green fodder is limited. In this case, Broiler goat rearing is best option especially in rural areas. Broiler goat production technology has been found to be high profitable when compared to rearing other farm animals. You need to understand that the selected goat kids for broiler goat rearing are just for meat production and not for breeding purpose. Let us talk little bit more about broiler goat farming in the following sections. Broiler goat production is highly suitable technology in areas where green fodder is not available (or) due to lack of grazing land. It is one of the techniques to improve the economy of rural farming community. Broiler goat rearing has been found to be highly remunerative compare to rearing other farm animals and it has been advocated as a better substitute of livelihood for the rural farmer.

Goat Rearing is one of the highly demanded businesses in the world. Broiler goat has been evolved to enhance goat meat production in areas were land availability is scarce and fodder become year. The browsing character of goats destroys the crops. Eventually goat rearing became very problematic. At this situation the new technology to grow goats in goat houses abandoning grazing, feeding high tech feed by reducing FCR to 2.5 and total removal of fodder fibre from the became a new innovation in animal industry.
1. Goats became one of the family members of farmers
2. It is mobile ATM
3. Goats play an important role in the financial up liftment of farmers than any other animals.
4. Goat farming is a profitable self-employment business.

What are Broiler Goat Kids?

As far as broiler goat raring is concerned, we don't have any specific breed for this purpose. The kids produced from goats (whatever breed available in your area) can be used for broiler goat rearing (both male as well as female kids).

Advantages of Broiler Goat Rearing

The following are main advantages of Broiler goat rearing:
1. As Broiler goats are meant for meat production, no need to worry about breeding technology.
2. As broiler goats are not allowed to graze on open spaces, this provides to raise them in hygienic disease-free environment. This can also protect them from any predators.
3. Apart from this, these broiler goats can be protected from eating poisonous leaves/plants/shrubs in open fields
4. Easy to manage and can produce quality tender goat meat (chevon).
5. Risk is less in broiler goat farming as they are raised in controlled environment.
6. Broiler goats are protected from heat, wind, predators and any severe climatic conditions since they grow in controlled and protected shelters.

7. Effective feed management is possible in broiler goat rearing.
8. It is easy to monitor goats and record keeping is easy.
9. Broiler goat rearing allows collecting the manure. Farmers can earn additional income with this.

Starting a Broiler Goat Rearing

Broiler Goat Rearing is better option for meat goat farming in rural areas where there is no grazing area or green fodder. Your regular goat experience good enough to manage the broiler goat rearing business. If you are a beginner, try to get some goat farming business project reports and watch any videos of goat management. If you are planning broiler goat farming on commercial scale for meat purpose, make sure to have goat business plan which may include construction of shed to marketing.

Parent Stock

This technique is highly applicable to the farmers having goats or already involved in goat rearing. There is no specific breed used for broiler goat rearing. The kids produced from these animals can be used for broiler goat rearing. For example, suppose a farmer is having 50 goats. Out of these 50 goats, may be 20 goats kidded (delivered) on an average of 2 kids/goat at a time. So that farmer can get totally 40kids. Out of these 40 kids (20 male & 20 female), the kids which are having higher birth weight and those not used for further breeding can be selected for broiler goat rearing.

Housing

Low-cost housing should be constructed in such a way in a raised platform (about 1 meter height from ground level) by using bamboo/wooden poles or 'pakka' building by establishing concrete pillars. Floor and side walls may be made of wooden material. Roof may be thatched with coconut leaves, grass or asbestos sheets. Average floor space per kid is 0.75 to 1 sq. metre. Floor should have at least 1 cm space between bamboos/wooden planks to allow passage of dung and urine down to the ground.

Goat Care in Broiler Goat Rearing

The broiler goat kids should be monitored regularly for any abnormal behavior and unusual feeding habits. It is advised to have your vet visit the farm once in a week. Any sick broiler goat should be isolated from the flock. Never mix male and female goats as our purpose is not breeding. Providing clean water 24 hours a day ensures healthy growth. Never allow goats to eat from other goat feeds. Clean the house floor and disinfect the house frequently to maintain hygienic conditions. Never allow broiler goat kids of the house or to open spaces.

Goat Feeding in Broiler Goat Rearing

Timely and proper feeding is another important factor that influences the growth rate especially body weight in broiler goats. The selected goat kids for broiler goat farming are reared intensively by providing concentrate feed @5 grams mixed with equal quantity of broken boiled rice at initial stages (2 week to 1 month). As time passes, you should gradually increase the feed amount day by day. The feed intake should increase like 7grams, 10 grams, and 15 grams like that. As supplemental feed, you can also add coconut cake, rice bran or ground cake with minimum level of 1 to 2 grams/day /goat kid to maximum of 150 to 200 grams/day /goat kid.

Liver tonic and fish oil may be given twice in a week @ 2.5 ml/goat/day initially and can increase gradually up to 5 to 10ml/goat kid/day. You can buy goat feed available in the market or prepare on your own by following feed ingredients.


Health Care in Broiler Goat Rearing

De-worming is regular practice of caring your broiler goats. Your veterinary doctor is right person to talk about this. Generally, de-worming is done once in 3 months. Make sure all the animals get vaccinated before entering into your farm.

Marketing of Broiler Goats

Goat meat is always preferred across the globe. As population is increasing, meat lovers are increasing so the demand for goat meat (chevon) is never ending. Marketing of broiler goat is very easy and you can sell these goats at your farm gate itself. Avoid any middle agent and try to sell directly for more profits. In case of broiler goat, you can sell them when they attain about 25 kg weights or at the age of 3 to 4 months.

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Advances in Nutrient Uptake Modeling

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Athulya S[1], Naveen Kumar A[1], Divya Pooja B[2]
[1]Ph.D. Scholar, Division of Soil Science and Agricultural Chemistry, IARI, New Delhi.
[2]Ph.D. Scholar, Division of Environment Science, IARI, New Delhi.

Introduction

A mathematical model is an equation or set of equations which represents the behaviour of a system. Simulation models have extensively been used in studying various aspects of plant physiology including nutrient accumulation by soil-grown plants. The models that have been developed fall into two general categories: empirical and mechanistic. Empirical models attempt to describe observed phenomena without hypothesizing how they happen. Such models are most often statistical ones, i.e., those which use response functions or may occasionally be derived from the compartmental analysis. On the other side, mechanistic models seek to explain how observed phenomena have happened. Mechanistic models are categorized as steady state and transient models. This approach requires understanding and mathematical description of the underlying processes. Falling somewhere between empirical and mechanistic models are the nutrient-uptake balance models which contain equations describing a few of relevant physical, chemical and physiological processes in a mechanistic way, while deriving most of the relationships from the statistical analyses. Even though all these models are prevalent, mechanistic models are widely used.

Mechanistic Models and Parameters Used for Nutrient Uptake Modeling

A step-wise approach to a nutrient-approach process should include the following sequence of events.

a. Movement of nutrient ions through the soil toward the sorbing root surface
b. Transport of ions through the membranes of root surface cells
c. Radial transport of ions toward the root xylem vessels
d. Acropetal transport in the xylem and distribution of ions in the aboveground plant parts

The mechanistic simulation models of nutrient uptake simplify the nutrient-uptake process by considering its dependence on the nutrient supply characteristics of a particular soil and on the nutrient uptake characteristics of the plant-root system. Generally, these models do not account for nutrient distribution within the plant and shoot-root interactions. In these models, nutrient supply characteristics of soil and plant parameters are considered. Once the model is developed, it has to undergo various steps such as verification and sensitivity analysis which involve comparison of actual nutrient uptake obtained experimentally and uptake predicted by model.

1. Steady State Models: Diffusion theory has been used in developing steady state models. Assumption made is that diffusion is the only transport mechanism of nutrients to plant roots and the diffusive flux is driven by concentration gradient. The higher the concentration difference in the soil solution between the soil and the plant root, the higher is the concentration gradient and it will lead to higher flux to the plant root. Steady state condition requires that the diffusive flux of nutrient to plant root is equal to its influx across the root (In). If the influx is known, then the concentration difference between the soil and the root surface needed for getting a diffusive flux equal, can be computed from the equation developed by Barraclogh from the model proposed by Baldwin *et al;*

$\Delta C_L = C'_{li} - C_{la}$

Where, 'C'_{li}' is the solution concentration in bulk soil and 'C_{la}' is the concentration at root surface.

1. Transient Models: With progressive absorption of nutrients by plant roots, their concentration at root surface changes continuously. Transient models try to describe this dynamic process of nutrient uptake and the concomitant changes in ion concentration and distribution in the rhizosphere.

a. Barber and Cushman model: Single nutrient uptake by a growing root system is often estimated by the Barber-Cushman model. The model solves the coupled equations of transport in the soil and absorption of nutrient by roots in fixed domains**.** This model was developed with the assumption that mass flow and diffusion are the two nutrient supplying mechanisms in soil to plant roots. This model simulates nutrient uptake by roots. It does so by assuming that roots are evenly distributed in the soil, and nutrient flow in the soil to the roots can be described by a one dimensional radial flow. The model includes a diffusion (dispersion) and a mass flow component which both may cause nutrients to move towards the roots. Once nutrients have reached the root surface, they are taken up actively by the root. Active uptake is described by Michealis Menten kinetics in the model (Figure 1).

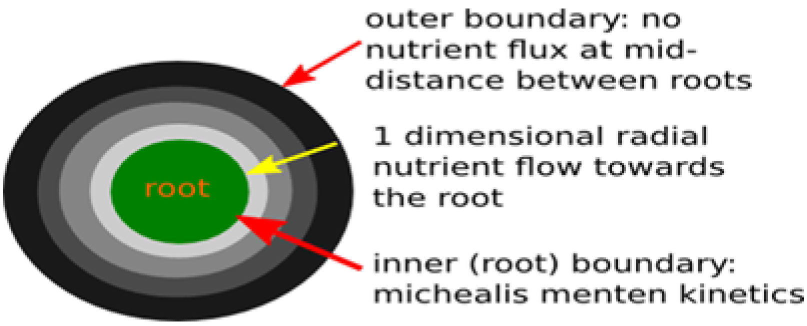

Figure 1

Nutrient flux (Jr) is given by,

$$Jr = De + (dCs/dr) + V_0C_1$$

Where, 'De' is the effective diffusion coefficient, 'r' is the radial distance, 'Cs' is the concentration of ions on solid phase that readily equilibrates with 'C_1', the concentration of ions in soil solution and 'V_0' is the rate of water flux into root.

The nutrient uptake by plant roots growing in uniform soil systems has been calculated as,

$$T = 2\prod aL_0 \rfloor J_r\,(a,S)\; dS + 2\prod a \rfloor (df/dt) \rfloor J_r\,(a,S)\; dS\; dT$$

Where,

'a' is the root radius

'J_r (a,S)' is the influx at the root surface

'L_0' is the initial root length.

Modeling Nutrient Uptake Using a Moving Boundary Approach

A study was conducted to determine whether a moving boundary model that accounts for increasing root competition could improve predictions of nutrient uptake (Juan *et al.,* 2000*)*. This model includes assumptions of the Barber-Cushman model and the moving boundary approximation. The model predicts nutrient uptake by coupling nutrient flux to roots and nutrient absorption on a variable domain in time. A moving boundary model for nutrient uptake that takes into account an increasing competition among roots for nutrient uptake from the soil by a growing root system that combines ion transport, absorption kinetics, and root growth simultaneously. A one-dimensional model is considered here: i.e., a single cylindrical root in a soil where it is assumed that the conditions of moisture, light, and temperature are controlled (as in a growth chamber). With these assumptions, the following model of one-dimensional nutrient uptake through a moving boundary problem to one phase in cylindrical coordinates is proposed. Total nutrient uptake can be obtained from the following formula, which can be considered a modified version of the Cushman formula.

$$U = 2\pi s_0 l_0 \int_{t=0}^{t=t_{\max}} J_c(t)\mathrm{d}t + 2\pi s_0 \int_{t=0}^{t=t_{\max}} \left[\int_{t=t}^{t=t_{\max}} J_c(t)\mathrm{d}t\right] \dot{l}(t)\mathrm{d}t$$

$$J_c(t) = \frac{k_a[C(s_0,t) - C_u]}{1 + \dfrac{k_a[C(s_0,t) - C_u}{J_m}}$$

Where, *Jc* (*t*) is the influx, *l*(*t*) is the longitudinal root rate growth, and *U* is computed from $t = 0$ to $t = t_{max}$

Multiple Ion Uptake Model

A multi-ion uptake model has been developed by Bouldin on 1989 and tested. The model calculates uptake of several cations and anions using conventional single ion models for each ion in each time increment. Therefore, no provision for interactions among ions was included in this model.

Mathematical Model for Water and Nutrient Uptake by Plant Root Systems

A mathematical model was developed by Roose and co-workers in 2003 which deals with modelling the simultaneous uptake of water and highly buffered nutrient, such as phosphate, by root branching structures from partially saturated soil. They used the simultaneous water and nutrient uptake model to investigate the effect that water movement has on nutrient uptake where, they have taken the diffusivity of nutrient in the partially saturated soil to be given by D_{nut} = Df with 'D' being the nutrient diffusivity in free water and 'f' for nutrient diffusion in the partially saturated soil content.

Conclusion

Mechanistic models of nutrient uptake consider diffusion and mass flow acting simultaneously to supply nutrients to the sorbing root surface. Plant parameters that determine nutrient uptake include those describing changes in root geometry and size due to root growth and others describing kinetics of the nutrient uptake process. Mechanistic models generally assume that nutrient uptake occurs evenly along the roots that are uniformly distributed in homogeneous and isotropic soil having no temporal and spatial gradients in volumetric moisture content. Uptake of immobile nutrients is mainly determined by the soil-supply parameters and is well predicted by the simulation models. In contrast, uptake of mobile nutrients that usually accumulate at the root surface is determined mainly by the plant-uptake parameters; prediction of uptake of those nutrients is subject to a much wider error due to uncertainties of applying kinetic parameters measured on hydroponically-grown plants to soil-grown plants.

Single nutrient uptake by a growing root system is often estimated by the Barber-Cushman model. The model solves the coupled equations of transport in the soil and absorption of nutrient by roots in fixed domains. The moving boundary model appears to provide a better description of coupling between transport, absorption of nutrient, and root growth than the Barber-Cushman model, and it improves the prediction for nutrient uptake in some tests. Complementary-ion effects occurring at the soil-root interface raise the need for developing a multi-nutrient uptake model that will simultaneously calculate uptake of several essential nutrients taking into account interactions among them.

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Commonly Used Chemotherapeutants in Aquaculture

Article ID: 40696

Siddharth Kumar Jatav[1], Ravikant[2], Domendra Dhurve[1], Shri Ram Yadav[1], Satyendra Katara[3]
[1]College of fisheries science, CCS HAU, Hisar.
[2]College of basic science and humanities, CCS HAU, Hisar.
[3]College of fisheries science, NDVSU, Jabalpur.

Introduction

Along with the continuous growth in the fisheries sector, immense opportunities are being created for entrepreneurship along with farmers in this business. In fisheries, new dimensions are being established day by day by using the latest techniques in an advanced way and also many types of scientific methods. In this series, due to scientification and modernization in the field of fisheries, many problems are also arising, in which the biggest problem is with diseases and the damages caused by them. Various types of drugs and chemicals are being used for the treatment of diseases and various types of chemical drugs are being used in aquaculture to destroy the different diseases and disease-causing factors known as chemotherapeutants. Due to the very good solubility of chemicals with water, they are being used at a very high level for treatment of different types of bacterial, fungal, parasitic diseases of fishes and water sanitization & disinfection. While the use of chemical drugs in the field of fisheries is proving to be a very effective solution for fish health management, many types of side effects are also being seen from these chemicals which directly and indirectly affect the pond environment, other aquatic organisms and at the same time it is being seen on the health of humans and animals who eat fish (Vaseeharan and Thaya 2014).

Various Types of Chemotherapeutants and their Effects

1. Formalin: Chemical preparation of formalin is done by dissolving 37% formaldehyde gas into water. Generally, formalin is used for bath or dip treatment of fishes against disease caused by most of the protozoan parasites. Formalin effectively kills parasite on fish gills, skin and fins. Formalin sometimes also used to control fungal infections on fish eggs but formalin it not used to treat any types of internal infections. Two brands of formalin Formalin-F (Natchez Animal Supply, Natchez, Miss.) and Paracide-F (Argent Chemical Laboratories, Redmond, Wash.) have been approved by FDA as a Parasiticide for use on fish. Short term bath of formalin can be delivered at a concentration of 50-100 ppm for 30 to 60 minutes and indefinite bath at a concentration of 15 to 25 ppm. In case of sensitive species like hybrid striped bass do not use dose of formalin more than 8-10 ppm. For controlling fungal infections on fish eggs high concentration of formalin up to 200 ppm for 15 minutes in fish hatcheries approved by FDA. The International Agency for Research on Cancer (IARC) of WHO classifies formaldehyde as "carcinogenic to humans", can cause nausea, coughing and burning sensation in eyes, nose and throat in the short term. Never use formalin when storage temperatures fall below 40°F (5°C) because at cold temperatures, formaldehyde is transformed into paraformaldehyde which is highly toxic material (Pathak et al., 2000).

2. Benzalkonium Chloride (BKC): Benzalkonium Chloride 50% & 80% is a colourless Liquid, Soluble in water under normal temperature used as sanitizer and broad-spectrum ponds disinfectant in aquaculture. It is a safe, rapid acting bactericide, algaecide and Fungicide. Shrimp farmers generally use it to reduce the concentration of planktons and dinoflagellates in closed pond systems and also prevention against bacterial and fungal diseases in fish ponds. In shrimps BKC supports for moulting & reduces black gill diseases. BKC helps for prevention and treatment of columnaris, bacterial gill disease, ulcer, tail rot-fin rot, gills Infection, dropsy, black Spot in Shrimp, cotton wool disease, saprolegniasis etc. diseases. BKC is used for pond disinfection with dose of 500 ml. per acre of pond twice in month and for treatment of infection or diseased condition use 1 litre per acre of pond for continuous 3 days for better result (Benskin et al., 2016).

3. Potassium Permanganate ($KMnO_4$): $KMnO_4$ is one of the first chemicals to be used as a chemotherapeutant in aquaculture, Potassium permanganate is an oxidizer which can be used to "disinfect" the external surfaces of fish. It effectively removes most external parasites, as well as fungal and bacterial agents. To treat against *Aeromonas hydrophila*, it can be used at 4 ppm in excess of potassium permanganate demand. For aquarium fish, for treatment of bacterial and fungal infections it can be used at up to 2-5 ppm as a dip treatment for 5 min. 2 to 3 ppm solution of KMnO4 is also used for disinfect aquaculture equipments such as nets, machineries, sampling equipments and tools. KMnO4 is low cost, effective and easily available chemotherapeutant for fish farmers (Stoffregen et al., 1996).

4. Iodine: Iodine is widely used as a disinfectant in hatcheries and fish ponds. Generally, Iodine 10%, 20% and 30% concentration are used for treatment of different types of bacterial and fungal diseases of fish and shrimp. In Aquaculture Povidone-iodine (PVP-I) is widely used chemical disinfectant, which can decrease the occurrence of different types of infections and diseases and also improve the survival. Iodine is used to treat all the diseases caused by GRAM + and GRAM – bacteria, fungus, protozoans, yeast etc and it can be used to treat injuries, infection on wounds. Iodine 10% is suitable treatment against bacterial gill disease, red fin disease, fin rot, tail rot, red spot disease, skin inflammation with dose of 500 ml to 1 litre/ acre of pond. Mixed solution of BKC 80% and Iodine 20% is very effective and kill 995 bacterial pathogens from pond water. Iodine solution is also used for disinfect fish eggs in hatcheries (Vaseeharan and Thaya 2014).

5. Copper sulphate ($CUSO_4$): Copper sulphate has historically been used in many countries as a chemotherapeutic to control and treat different types of diseases caused by bacterial and fungal pathogens in freshwater and marine water fish ponds and hatcheries. Copper sulphate dissolves in water and splits into copper and sulphate ions and disappears from the water column rapidly after application and accumulates in the bottom sediments. 0.25-1 ppm dose of CUSO4 is used in shrimp hatcheries for control of vibriosis, filamentous bacterial, larval myosis, bacterial & vibrio infections etc. Adverse effects of copper sulphate in humans can cause nose, mouth and eye irritations, as well as headaches. Chronic exposure can lead to Wilson's disease and liver, brain, nervous system, kidney and eye damage. Excessive copper concentrations in the environment can be toxic to plants, contaminate forage and harm livestock and other animals, and damage the soil biota (Pathak et al., 2000).

6. Methylene Blue: Methylene Blue is a cationic dye, redox indicator. In aquaculture, it used to treat many types of bacterial, fungal and parasitic diseases and has commonly been used to treat fish eggs to ensure they are not lost to fungal overgrowth. Generally, Methylene Blue is an aquarium-safe disinfectant and can also be used for the treatment of ammonia and nitrite poisoning. 2-3 ppm dose of methylene blue is used for dip treatment for 30 minutes in case of bacterial and fungal infections (Benskin et al., 2016).

7. Malachite Green: Most effective Triarylmethane dye which is also known as aniline green, benzaldehyde green, china green. In aquaculture, it is often used as an anti-fungal for eggs in hatcheries, in spite of growing concern regarding potential health hazards. It is most effective against external parasites, particularly when combined with formaldehyde. Malachite Green is also quite effective in controlling fungus on fish eggs. It is used for immersion treatment with dose rate of 0.15-1 ppm for aquarium fishes. Mixture of Formalin and malachite green oxalate are widely used for the control of fish and shrimp diseases caused by fungi and protozoan and crustacean parasites (Vaseeharan and Thaya 2014).

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Use of Cacti and Succulents in Landscaping

Article ID: 40697

T. Navya Swetha[1]
[1]Assistant Professor, SKLTSHU, Mojerla.

Introduction

Cacti are without doubt one of the most typical group of succulents. It is presumed that the ancestors of cactus family first appeared on the scene at end of the Mesozoic & beginning of Tertiary periods. Succulents are found anywhere from tropical region, sub-tropical and arid regions, less common in temperate areas. The water is stored in three basic organs like stem, roots and leaves special cell Water parenchyma. Cacti and succulents are a group of plants which have special structures to store water in thick fleshy leaves or stems. They thrive best in sunny situations and are light loving. They need little care except when actively growing. There is a clear distinction between both. Cactus is characterized by the presence of areoles, which often look like woolly cushions carrying spines, hairs or glochids and the flowers arise from or near the areoles. The spines in a cactus are modified leaves which provide shade against scorching sun and help in conservation of moisture besides protecting against birds and animals. All the cacti are succulents on account of storing water but all the succulents are not cacti.

Cacti and Succulents in Landscaping

1. Xeriscaping: Xeriscaping is landscaping that eliminates supplemental water from irrigation. Mainly practiced in desert areas. Cactus and succulents are more used in xeriscaping as they need less water for their growth.

Species used in xeriscaping: *Agave bracteosa, Delosperma basuticum, Dudleya cymose, Opuntia ellisiana.*


2. Rock Garden: Type of garden were extensive use of rocks along with plants native to alpine or rocky environment.

Plants used in rock garden: Pony tail palm, Opuntia, Agave, Kalanchoe, Yucca, Sedum, Furkaria.

3. Rowing cacti in tufa: Small cacti and other succulent plants can be grown in holes in tufa or limestone blocks. Choose small plants native to limestone areas. Eg: *Escobarias and Mammillarias, Tuberculosa.*

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1. A natural example of cacti growing on a heavily eroded block of limestone, near Dog Canyon in the Big Bend National Park, Texas.
2. Examples of natural rock gardens in shallow depressions on sloping rock faces in Colorado.

4. Indoor gardening: Indoor gardening is a technique used to grow plants indoors. This might be for decorative purposes, such as the trees and flowers sometimes seen in shopping malls, or the trailing vines sometimes used in restaurants to provide a sense of serenity and privacy. Even office buildings can be used for indoor gardening, and the beneficial impact that growing plants has on indoor air quality has long been proven.

Species used in Indoor gardening:

Buros tail

Christmas cactus

Crown of thorns

Hens-and-chicks

Medicine plant

Jade plant

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6. Terrariums: It is the art of growing plants in glass containers. Terraria are often kept as decorative or ornamental items. Eg: *Peperomias.*


7. Vertical gardening: It is a partially or completely with greenery that includes a growing medium,such as soil or substrate. Eg: *Sempervivum, Echeveria* etc.

8. Carpet bedding with succulent plants: A patterned arrangement of low or clipped herbaceous and usually variegated colored foliage plants distinguished from design bedding.


Carpet bedding at the RHS gardens, Wisley

It including large numbers of succulents such as: Eg: *Echeveria secunda, Sedum spathulifolium*

9. Bonsai: An art of growing tree or shrub in a shallow container and trained to resemble full size tree but in miniature form.



Adenium plant **Plumeria** **Jade plant**

10. Hanging baskets: A Hanging basket is a suspended container used for growing decorative plants. Typically, they are hung from buildings, where garden space is at a premium, and from street furniture for environmental enhancement. Eg: Sedum, Hens and chick and Echeveria.



11. Pot plants: Potted plants refer to plants that are planted and grown in containers rather than in the ground. Potted plants are ideal for smaller spaces or for more delicate flowers that are particularly susceptible to environmental factors and pests.



Echeveria Sedum Hen-and-chicks

Kalonchae

12. Displaying of cacti and succulents: Ideally choose cacti or succulents that remain small and compact and are of a similar type. Select plant within same family based on particular geographical areas. Eg- *Mammillarias, Gymnocalycium* and *Rebutias*.

13. Home gardening:

Potassium Deficiency – Paddy

Article ID: 40698

Dharani Prabha. N[1], Anushya. S[1]
[1]S. Thangapazham Agricultural College.

Abstract
Potassium is an essential plant nutrient that improves root growth and plant vigor, helps prevent lodging and enhances crop resistance to pests and diseases. Potassium is mobile in the plant *and* quite mobile in the soil. This deficiency affects canopy photosynthesis, thus affecting crop growth. It is the major problem throughout the growth cycle. In Asia potassium deficiency is the major problem.

Introduction
Potassium is often the most limiting nutrient after nitrogen (N) in high yielding rice systems. K fertilizer needs to be applied in adequate amounts in most irrigated rice fields. Other nutrients need to be applied in balanced amounts to ensure a good crop response to K fertilizer application and to achieve a healthy and productive crop.

Occurrence
1. Potassium deficiency occurs under conditions like.
2. Excessive use of Nitrogen (N) or N and P fertilizers with insufficient K application.
3. Direct seeded rice during early growth stages, when the plant population is large and root system is shallow.
4. Cultivar differences in susceptibility to K deficiency and response to K fertilizer.

Symptoms
1. Symptoms appear first on older leaves, then along the leaf edge, and finally on the leaf base. Affected plants would also have short, droopy upper leaves that have a "dirty" dark green color. Leaf tips and margins may also dry up.
2. The general pattern of damage is patchy within the field, affecting single hills rather than the whole field.

Management
1. Estimate K input from indigenous sources to assess site-specific K requirements.

2. Increase K uptake by improving soil management practices on root health (e.g., deep tillage to improve percolation to at least 3-5 mm d-1 and to avoid excessively reducing conditions in soil).
3. Establish an adequate population of healthy rice plants by using high-quality seed of a modern variety with multiple pest resistance, and optimum crop maintenance (water and pest management).
4. Incorporate rice straw. If straw burning is the only option for crop residue management, spread the straw evenly over the field (e.g., as it is left after combine harvest) before burning. Ash from burnt straw heaps should also be spread over the field.
5. Apply optimum doses of N and P fertilizers and correct micronutrient deficiencies. Apply K fertilizers, farmyard manure, or other materials (rice husk, ash, night soil, compost) to replenish K removed in harvested crop products.

Conclusion

Rice deficiency in K promoted the infection of *S. oryzae* and decreased the relative abundance of the endophytic community. Sufficient K supply increased the relative abundance of Proteobacteria, Burkholderia, Stenotrophomonas, Allorhizobium, and Pseudomonas spp. Under *S. oryzae* infection.

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Seed Priming in Black Gram

Article ID: 40699

M. R. Padma Priya[1], A. Krishnaarivanandhan[1], P. Kaviyarasu[1], M. L. Mini[2]
[1]M. Sc Scholar, Department of Seed Science and Technology.
[2]Associate Professor, Department of Biotechnology, Agricultural College and Research Institute, Madurai, Tamil Nadu.

Introduction

Black gram (*Vigna mungo L.*) is one of India's most important legume crops. In India it is grown in the states of Maharashtra, Andhra Pradesh, Uttar Pradesh, Madhya Pradesh, Tamil Nadu and Bihar. It is highly nutritious containing about 26 percent protein, rich in vitamins and minerals like potassium, phosphorus, calcium and sodium. Black gram is the third most important pulse crop in India representing 15% of the total pulse area and 9% of total pulse production. Black gram is a drought resistant crop, hence ideal for dryland farming and is often used as an intercrop with other crops. In addition, it helps to maintain the fertility of soil by enhancing soil physical qualities and fixing atmospheric nitrogen. However, the productivity of black gram is low due to its cultivation in marginal and rainfed areas with poor soil moisture, soil fertility and lack of high-yielding varieties and hybrids. Abiotic stresses are major global problems affecting seed germination, emergence and vigour of seedling and ultimately crop yield. India being an agricultural country urges the need for simple, effective and manageable technology to enhance the establishment of crops under all environmental conditions.

Different techniques can be used to enhance crop yield of which, seed priming is a simple and suitable technique to synchronize seed germination and increase emergence and establishment on the farm. Seed priming is a controlled hydration process followed by the drying of seeds that allows the seed to imbibe water and begin internal biological processes necessary for germination, without allowing the seed to germinate. Seed priming initiates metabolic activity to occur, but it prevents the emergence of the radicle. During seed priming various physiological and biochemical changes with enhanced antioxidant activities and improved repair process. Hydration followed by dehydration treatments reduces the membrane damage and maintains mitochondrial function. The efficacy of hydration and dehydration treatment enhances the vigor and viability of the seed. Seed priming favors faster germination, uniform establishment, more vigorous plants, better drought tolerance, early flowering and more yields.

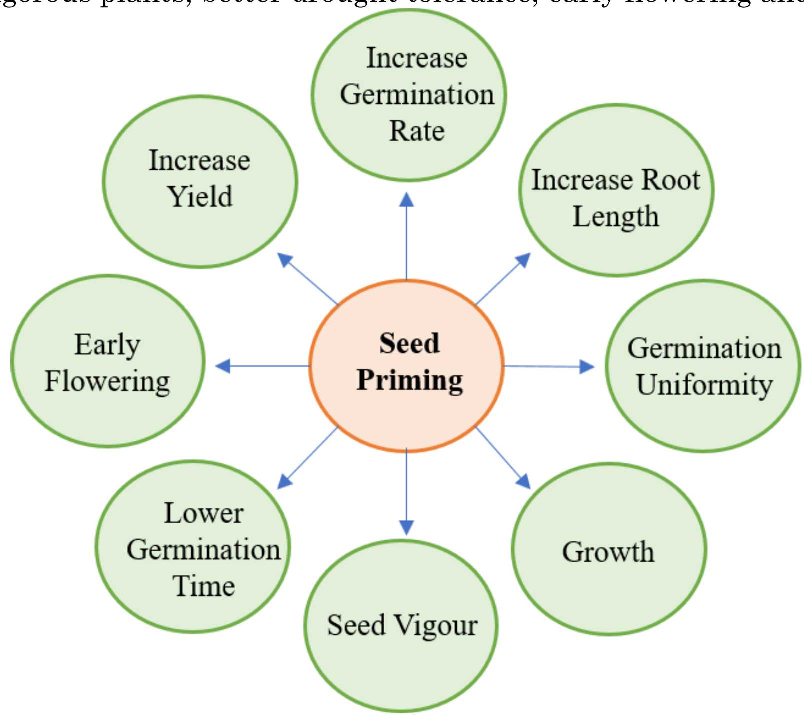

Fig: Benefits of seed priming

Different Methods of Seed Priming

Hydropriming is a technique that uses water to soak seeds, drying them for dehydrating and then sowing the next day. This leads to an increase in the process of germination and accelerates seedling growth and strength.

Halopriming is a technique that involves submerging seeds in solutions of inorganic salts *viz.* calcium chloride, potassium chloride, sodium chloride, etc. Some of these salt solutions may exert direct or indirect nutritional effects.

Osmopriming involves soaking seeds in a solution of osmotic priming material for a certain period followed by air drying before sowing. Osmotic solutions used are of less water potential so water uptake is restricted. Some of the osmotic priming agents are sugar, and polyethylene glycol (PEG).

Hormonal priming involves seed imbibition using phytohormones to activate seed metabolism.

Biopriming involves the treatment of seeds with beneficial microorganisms which protect plants from pathogens and improve their growth. Beneficial microbes include *Pseudomonas fluorescens*, *Rhizobium sp.,* etc.

Chemical priming is another type of priming where seed treatment is carried out using natural substances (organic acids, plant extracts, chitosan, polyamines, mannose, trehalose, etc.) or synthetic compounds (sodium nitroprusside, sodium hypochlorite, etc.).

Seed Priming of Blackgram

Several studies report the effect of seed priming on the growth and yield parameters of black gram. Seed priming using 1% KCl resulted in the highest seed yield, pod number and pod weight per plant. Increases in seed germination, root length, shoot length and vigour index were also reported. Seed priming with 1% N: P: K-10:26:26 solution when followed up by the foliar spray of N: P: K-20:20:20 @ 2% solution, showed maximum growth and yield attributes. Halo-priming of seeds with NaCl@1% showed better results in root length and mean germination time. Osmo-priming with PEG600 up to 5% concentration was found beneficial.

Conclusion

Seed priming is an efficient and low-cost technique that enhances germination, leads to early flowering and maturity, breaks dormancy and makes the crop resistant to abiotic stresses and soil-borne destructive diseases by inducing systemic resistance. It is clear that use of different priming techniques has been studied on varied crops and found to be beneficial in terms of crop yield. So, seed priming can be considered as a better solution against problems related to germination when seeds are grown under unfavorable conditions.

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Fruit Flies: An Emerging Pest of Fruits and Vegetables

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Shrinjal Suman[1], Dr. S. K. Mandal[2]
[1]M. Sc Scholar, Department of Entomology, PGCA, RPCAU, Pusa, Samastipur.
[2]Assistant professor & Scientist, Department of Entomology, PGCA, RPCAU, Pusa, Samastipur, (Bihar)-848 125.

Abstract
Fruit flies are dominant pests of fruits and vegetables. These pests have been a major constraint in fruit and vegetable production. Fortunately, in addition to pests' fruit and vegetable ecosystem is favorable for their natural enemies. To combat the burgeoning problem, relying on the on the insecticides is not desirable in the present day of global consciousness towards health hazards and environmental safety. One of the strongest alternatives for the management of fruit flies would be cultural and mechanical control practices. Bait Application Technique (BAT) and Male Annihilation Technique (MAT) of fruit flies with emphasis on spot application of BAT and cover spray of friendly insecticides.

Keywords: fruit flies, fruits and vegetables, management.

Introduction
Fruit flies have been reported to be of economic importance as majority of them cause extensive damage to many fruits and vegetables. These flies are widespread over the entire world and highly predominant in the tropical and sub-tropical areas. About 4500 species of these flies have been reported from different region of the world. However, 392 species have been described in India. Most common species attacking these crops are oriental fruit flies, *Dacus dorsalis* (Handel) and melon fruit fly, *Dacus cucurbitae* (Caquillat). These are polyphagus pests and also found all over the world. Adult flies are strong fliers and transverse the distance of 1 to 2 km in search of suitable host plants. Generally late maturing varieties of fruits and vegetables are most susceptible to the attack if the fruit flies (Butani and Jotwani, 1983).

Species of Fruit Fly
Forty thousand five hundred species of fruit flies have been found in different region of the world including India. The major species are *Dacus dorsalis* (Hindel), *D. correctus* (Bezzi), *Bactrocera zonata* (Bezzi*), D.divessus* (Coquillett), *D. incissus* (Walker), *D. tau* (Walker), *D.zonatus* (Saunders), *Ceratitis capitata* (Wieldemann), *D.tryoni* (Piroggot), *Rioxa pornia* (Walker), *D.cucurbitae*(Coquillett), *D.pedestris*(Bezzi), *Toxotrvpana curvicauda* (Gurst), *Carpomyia vesuviana* (Costa), *D.ciliatus*(Loiw), *Myrioparadalis pardalina*(Bigot), *D.correctus* (Bezzi), *D.duplicatus* (Bezzi), and *D.maculipinnus*(Doleschall).

Host Range
Fruit flies are polyphagous pest having a wide range of hot plants as given in table number 1.
Table-1 Fruit fly's host range:

Sl. No	Species	Host Plant	
		Major Pest	Minor Pest
1.	*Dacus dorsalis* (Hindel)	Mango, guava, banana	Peach, pear,plum,sapota,fig,cherry,apple, Ber,citrus,loquat,apricot.
2.	*D.zonatus* (Saunders)	Custard apple	-------
3.	*D.dieversus* (Coquillett)	Papaya,jamun	Banana,citrus,guava,mango.
4.	*D.correctus* (Bezzi)	Fig	Ber, citrus, mango, peach, sapota.
5.	*Carpomyia vesuviana* (Casta)	Ber	----------
6.	*D.cucurbitae* (Coquillett)	Melon	Citrus, guava, papaya, peach.
7.	*D.ciliatus* (Loiw)	Apple	Melon

8.	*D.duplicatus* (Bezzi)	Peach, pear	
9.	*D.incisus* (Walker)	Guava, mango	
10.	*D. maculipenis* (Dalischall)	Peach	
11.	*D. pedestris* (Bezzi)	Papaya	
12.	*D. scutellaris* (Bezzi)	Citrus	
13.	*D. tau* (Walker)	Citrus, mango	
14.	*Myiapardalis pardalina* (Bigot)	Melon	
15.	*Toxotrypana curvicauda* (Curstacker)	Papaya	

Source: Butani (2016)

Distribution

This is one of the most serious of all fruit flies and widely distributed in India and South-East Asia. It has also been recorded in Malaysia, Indonesia, Philippines, Australia and Hawaii to Pakistan. However, *Dacus ciliatus* commonly called as Ethiopian melon fly is of African origin, now widely distributed in European countries, Africa, Middle East, Pakistan, India etc.

Adult Identification of the Species

The immature form of *Dacus dorsalis, D. zonata, D. cornitus, D. incises and D. tau* are similar to each other and difficult to distinguish from one another but the adults however, can be distinguished through microscopic inspection by the taxonomists (Kapoor, 1972).

Adult of *D. dorsalis* and *D.diversus* look alike, both being of same size, shape and having similar type of wing venation, but thorax of *D. diversus* is black with yellow middle stripe, whereas that *D. dorsalis* is ferrugineas and without any yellow middle stripe. *B. cucurbitae*, the melon fruit fly, is larger in size than other fruit flies (except D. tau) and has distinctly different wing venation.

Seasonal Cycle and Behavior of Fruit Flies

Dacus dorsalis is active throughout the year in South India, whereas in northern parts the pest hibernates during winter (November to March) in pupal stage. The flies appear late in spring in such fruits that are about to ripen and the population increase rapidly during summer. The pest being polyphagous, breeds profusely on guava during March, shifts to loquat, apricot and plum during April-May, thereon to peach and fig (June) and finally on mango (June to August). After August the flies breed mostly on guava but are also found on pear, fig, apple, citrus and unripe banana (Naryanan and Batra, 1960). Fruit flies are strong fliers and can fly up to 2kms in search of suitable food.

Bactrocera cucurbitae is also highly polyphagous and though its preferred hosts are musk melon, snap melon, bitter guard and snake guard (Butani, 1975), as many as 70 host plants have been listed by Batra (1953). In nature, the population is generally low during dry weather and increase rapidly with adequate rainfall.

Losses by the Fruit Flies

The exact loss caused by these flies has not been systematically worked out, though it is estimated that more than 50 per cent of fruits are either partially or fully damaged by one or the other species of the fruit flies (Singh, 1966).

Damage caused by the fruit flies:

1. Plant injury: Female fruit flies most often lay their 2 to 15 eggs in clusters on the fresh flesh of the fruits, vegetables and other plant parts. The eggs hatch into larvae (maggot)_ which most often feed on the inside of the hosts and convert the host tissues in a soft and spongy mess.

2. Economic injury: Fruit fly population can often be present at low levels without causing significant economic problems, thus management may not be necessary. If high population are causing more severe damage, the management practice may be needed. The damage to crops caused by fruit flies result from oviposition in fruit and soft tissues of vegetative or reproductive parts of certain plants.

Feeding by the larvae (maggots). Decomposition of plant tissues by invading secondary microorganisms (fungi and bacteria).

Damage Symptoms

This is a polyphagous species. Nature and extent of damage depends on type, size and condition of fruit, availability of different hosts and population density of the flies. The most preferred hosts are mango, guava, litchi, citrus and papaya in India. Affected fruits usually show signs of oviposition punctures and ripe fruits with a high sugar content exude a sugary liquid. Maggots (larvae) after hatching migrate to pulp and start feeding. Feeding of maggots on the pulp induce rotting of fruits and renders them unfit for human consumption.

Management Strategies

The management practices are basically dependent on the symptoms (applied singly/in combination) such as cultural, physical, large scale application of bait spray, use of trap (for population suppression) and post-harvest treatments. In some area of the world other management practices like biological, male annihilation and sterile insect technique have also been used for successful population suppression of fruit flies. The management of Bactrocera species is rather difficult and largely determined by their biological attributes as given below:

1. Adults are highly mobile and active.
2. Adults have wide climatic tolerance.
3. Highly polyphagous in nature.
4. Females with high productivity.
5. Overlapping of generations.
6. Short life cycle.

Cultural and Mechanical Control Measures

1. Ploughing of orchards during November-December reduces the fly population by exposing the larvae/pupae to sun's heat and other predators which are mostly present at 4-6 cm depth in soil surface.
2. Collection and disposal of all the fallen and infested fruits and destroy these immediately either by burning or deep burying.
3. If the trees are few in number, bagging the fruits with cloth or paper bags to prevent the fly from egg laying on ripening fruits.
4. Avoid infestation of fruit flies by early harvesting of mature fruits.
5. Langra variety is resistant to fruit flies.
6. Monitoring the fruit fly population in orchards by using methyl eugenol traps @ 10 traps/hectare. This also helps in mass trapping and if done on a large scale on community basis, it can reduce the pest density to appreciable level.
7. Pheromone traps: Using pheromone traps having 0.1% methyl eugenol + 0.1% malathion or 0.1% dichlorvos from April to June. About 10 traps are sufficient for one hectare of orchard.

Chemical Control Measures

1. Chemical control of these flies is rather difficult because maggots are invariably inside the fruits, pupae in the soil and adult flies are active on wings.
2. Bait application technique (BAT): Spray with Acephate 75SP @ 1gm/l or Profenphos 50ec @ 1.5 ml/l plus protein hydrolysate or molasses 1gm beginning at egg laying stage.
3. Male annihilation technique (MAT): 5X5 cm^2 wooden blocks soaked in a solution of ethanol: methyl eugenol: malathion in the ratio of 6:4:1 for 48 hours @10/hectare.
4. Chemical insecticides: Many insecticides have been used to manage fruit fly population and are following:
5. Dimethoate 30EC @2ml/l
6. Diazinon 20EC @1.25ml/l
7. Fenthion 50EC @1.25ml/l
8. Deltamethrin 2.8EC @0.5ml/l
9. Dichlorvos 76EC @1.0ml/l of water.

10. Spray these insecticides alternatively at weekly intervals as ripening of fruits commences from June-July onwards till the rainy season is over in pest endemic area.

Conclusion

Unfortunately, fruit flies are notorious pests of some fruits and vegetables for which satisfactory management measures are still not available. Strategy for the pest management in fruits and vegetables has necessarily to be somewhat different from cereals, cotton, oilseeds, pulses and sugarcane crops. In most of the cereals, there may be hardly any time when the pest infestation occurs and the harvest of the produce (fruits/vegetables) any time. Therefore, as far as possible emphasis should be given to using cultural, mechanical and biological control measures to identify and sow resistant cultivars where available.

Chemical control measures should be restored to when it becomes unavoidable. The choice of insecticides and time of application are of utmost prime importance. Use of insecticides with long persistence should never be recommended. Choice should be restricted to the insecticides with low mammalian toxicity.

Since fruits and vegetables are daily consumable and are a part of our day-to-day food, the eco-friendly tactics make it feasible for consumption of healthy diet.

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Heavy Metal Toxicity in Animals

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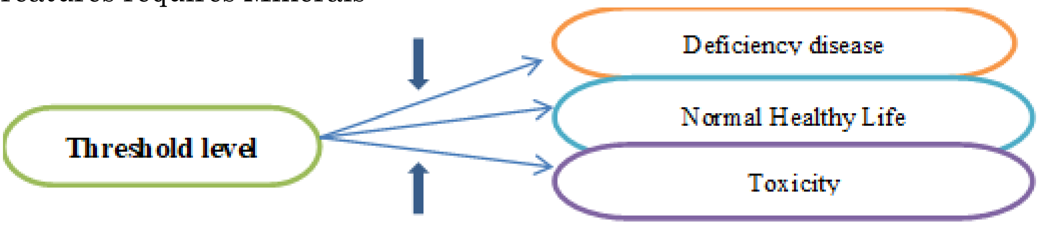
Pranjali Bhaudas Meshram[1], Abasaheb Kalyan Parade[1], Dr. Dilip Deokar[2]
[1]Ph.D Research Scholar & [2]Senior Scientist,
RCDP, Mahatma Phule Krushi Vidyapeeth Rahuri. Department of Animal Husbandry and Dairy Science.

Introduction

1. All Living Creatures requires Minerals



2. Naturally Metals Are distributed in environment during Earth's origine.

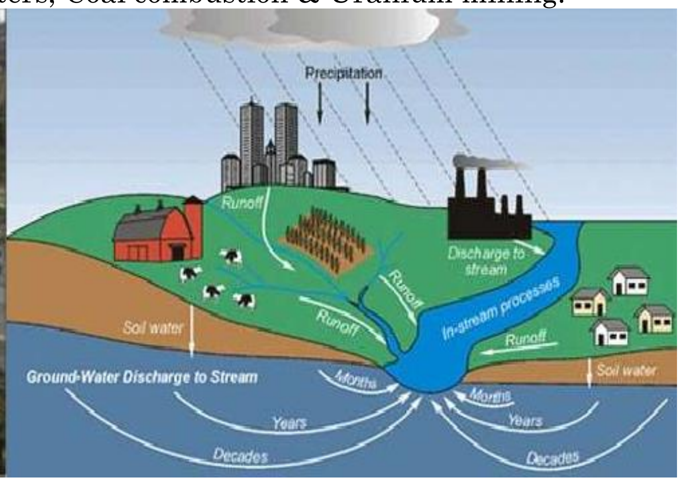
Rapid industrialization. Overgrowing urbanization. Environmental manipulation. Any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations.

On Health Effects Basis

1. Essential-Cu, Zn, Co, Cr, Mn, Fe
2. Non-essential-Ba, Li, Zr
3. Less toxic-Sn, Al
4. Highly toxic-Pb, Hg, Cd

Primary Sources of Heavy Metals

Pb-Battery plant, Refinery, Smelter, Fuel combustion, Leaded gasoline, Lead-based paints, Lead soldered food cans, Lead plumbing pipes & automobile exhaust (Tetraethyl lead).
Hg Refinery, Plastic, Paints, Antiseptic, Scientific instruments, Photography, Fuel combustion.
Cd Tannery, smelter, battery crushing unit, mining, Electroplating, Pigments (Cd yellow) and plastics.
As Pesticides, Wood preservative, Glass/Copper smelters, Coal combustion & Uranium mining.

Secondary Sources of Heavy Metals

Industrial & Domestic wastage directly/indirectly release in water **(Pb, Hg, Cd, As).**

Agriculture Soil Contaminated by Heavy Metals through

1. Long-term use of phosphatic fertilizers **(Cd)**
2. Sewage/sludge application **(Hg, Cd)**

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3. Dust from smelters, industrial waste **(Pb, Hg, Cd, As)**
4. Bad watering practices in agricultural lands **(Pb, Hg, Cd, As).**

Plants are Contaminated by Heavy Metals through

1. Excessive use of fertilizers/pesticides/insecticides
2. Plants growing in soil contaminated area
3. Irrigation of crop by contaminated water
4. Most of the animals affected Grazing in contaminated area.

Crops growing in contaminated soil

Lead (Pb)

Mostly, the bulk of Pb is received from food. Lead is highly toxic metal and its routine use has caused excess environmental contamination and health related problems in many parts of the globe. It is a bluish or silvery grey soft metal with atomic number 82. It gets accumulated in the liver, kidney, brain and bone. Its half-life is around 1–2 month in blood, but it is upto 20–30 years in case of bone. The lead poisoned animal can be considered a risk to public health.

Source:

a. Mining
b. Fossil fuel burning ig. petrol additives
c. Lead based paints/ pigments and compounds
d. Gasoline
e. Industrial emission/ air near a point of source emissions
f. Batteries
g. Contaminated water
h. Deposition of dust and rain containing metal on crops and soil.

Sign of Lead Toxicity:

a. Animals deficient in calcium, iron and zinc are more susceptible to be poisoned with lead, because there is increased absorption of this mineral element.
b. Lead excretion from the animal body occurs by bile, urine, feces and milk
c. Lead passes the placental barrier in high concentrations and is deposited in fetal tissues
d. Subacute lead poisoning- muscle weakness, ataxia, abdominal pain and convulsing, Head pressing behaviour.
e. Acute lead poisoning – walking in cicle, muscle twitching mainly in the head, ear and neck, salivation , blindness, sudden death.
f. Chronic lead poisoning- opaque hair, thickening of phalange epiphyses, moderate anemia. severe depression, incoordination, ataxia, muscle twitching, opisthotonos.

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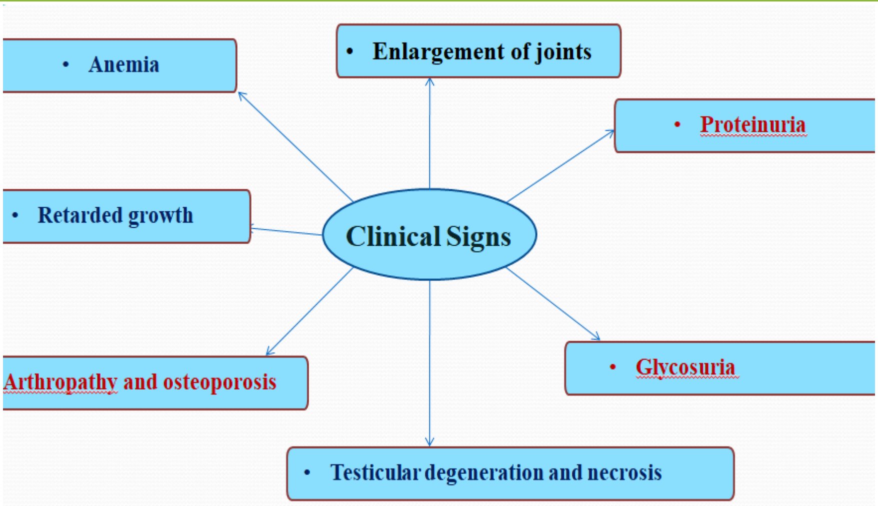


	
Cattle : show head pressing behavior	**Cattle: advanced stages of lead poisoning, become frenzied, bellow, stagger and crash into obstacles**

Treatment: Securely fence off the risk (fence farm dump, sheds). Magnesium sulphate drench- absorbed lead from particles in the gut. The therapeutic dose for cattle is 25 mg of thiamine/Kg of body weight subcutaneously twice a day and for sheep, 75 mg of thiamine/Kg. 200 to 300 grams of magnesium sulfate orally, in an attempt to interact with magnesium sulfate to form lead sulfate, which precipitates and is excreted in feces.

Mercury (Hh)

Liquid forms at room temperature. Significant disturbance to aquatic lives. Young ruminants more susceptible. Methylated forms of Hg. Animals adverse neurological and behavioral change.

Treatment: Efforts to reduce exposure via food or water sources are important oral administration of activated charcoal (1–3 g/kg) and sodium thiosulfate (0.5–1 g/kg) will bind mercury and limit absorption. Vitamin E and selenium, which are antioxidants, may limit oxidative damage.

Chelation therapy may be useful if treatment is started soon after exposure, before nephrotoxic effects become severe. Because degenerative changes are permanent and there are serious food safety concerns associated with mercury poisoning, treatment is highly discouraged.

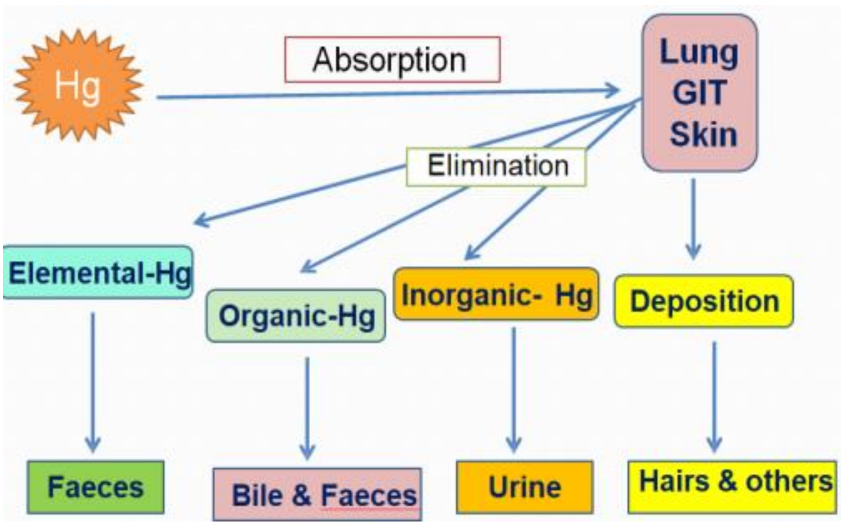
Cadmium (Cd)

This is a polyphagous species. Nature and extent of damage depends on type, size and condition of fruit, availability of different hosts and population density of the flies. The most preferred hosts are mango, guava, litchi, citrus and papaya in India. Affected fruits usually show signs of oviposition punctures and ripe fruits with a high sugar content exude a sugary liquid. Maggots (larvae) after hatching migrate to pulp and start feeding. Feeding of maggots on the pulp induce rotting of fruits and renders them unfit for human consumption.

Source: Cadmium is present in various materials as anticorrosive coating, pigments, stabilizers, PVC products, material galvanization, battery components, eliminated gas from motor vehicles, phosphate fertilizers, pesticides. Natural activities - weathering, river transport, volcanic eruptions. Human activities- mining, smelting, tobacco smoking, incineration of municipal waste, and manufacture of fertilizers. Industrial pollution.

Treatment: Thus, animals deficient in calcium, iron and zinc are more susceptible to be poisoned by cadmium Administration of diets with high molybdenum concentration reduces cadmium accumulation in sheep organism. Iron prevents if signs of cadmium poisoning observed. Vegetable has two chemical compounds called phytochelatins and phytic acid that bind to cadmium. Copper and manganese increase cadmium concentration in organism. Avoiding grazing of animal in polluted field. In animal diets, the maximum concentration of cadmium tolerated is 0.5mg/kg.

Arsenic (As)



More abundance in the Earth's crust 1.5–3.0 mg/kg. Used as first drug to cure syphilis by Paul Erlich. The use of insecticides and pesticides, veterinary drugs are the major sources for the exposure of animals. Most extensive exposure through drinking water. Principal source of threat to human. During the chronic cases the site of actions are kidney, liver and skin. The signs are manifested in the form of hyperkeratosis of skin and damages in kidney and liver.

Signs of Arsenic Toxicity:

Cattle	Buffalo	Sheep	Goats
Diarrhea Loss of appetite Muscular weakness Ataxia Sudden death Icteru	Loss of body weight General weakness Dehydration Anemia Hemorrhages	Body weight Body temperature Heart rate	Animal was dull and depressed Reddish color of urine. Weight was reduced Pustule formation in the skin

Treatment: The administration of sodium thiosulfate with dose of 40 mg/ kg intravenous (IV) for 8 hours has the useful effects in removing the arsenic from the body and maintenance of renal insufficiency. However, the antioxidants like vitamin E can also be used to ameliorate its toxic effects.

Copper

Copper is a metal considered an essential nutrient to be incorporated in the diet of all the animals. If taken in large amount it may prove harmful. Sheep are most susceptible farm animal species to copper poisoning, with goats being less susceptible than sheep and cattle being less susceptible than either sheep or goats. Copper that is ingested stored in the animal's liver.

Sources: Consuming plants contaminated by copper-containing pesticides. Eg. Copper sulfate, copper hydroxide, cuprous oxide. Consuming copper products that are used for algae and snail control. eg. Copper sulfate. Use of copper-containing anthelmintic (dewormers). Copper sulphate. Use of copper-containing foot baths to treat foot rot. Pasture that has been fertilized with swine manure. 125- 135 mg/kg Pasture that has been fertilized with poultry litter. 80-90 mg/kg

Signs of copper poisoning:

a. Weakness
b. Yellow Discoloration of The Mucous Membranes of The Eyes.
c. Gun Metal Kidney.
d. Dark Brown or Red Colored Urine.
e. Fever.

Prevention & Treatment

Poultry manure (litter) and swine manure contain potentially dangerous concentrations of copper, sheep and goats should not be allowed to graze pastures where these have been applied as fertilizer. Do not use copper sulphate for the control of snails in areas where sheep are grazing. Molybdenum salts may be added to the diet to slowly decrease copper levels in the liver. Dietary supplementation with zinc acetate (250 ppm) may be useful to reduce the absorption of copper.

Selenium (Se)

Selenium (Se) is an essential micro-mineral to animals. This mineral element is part of several selenoproteins, including glutathione peroxidase. Animals ingest high doses of selenium.

Source: A high intake of selenium by animals may be due to several factors. The consumption of plants that have high concentrations of selenium. Mandatory accumulating or primary indicator plants. Secondary accumulating plants. Passive accumulating plants. Due to soil and pasture contamination by industry wastes with high selenium concentration. Scarcity of rain also make liable animals to selenosis.

Symptoms:

a. Acute Selenium Poisoning (Alkali Disease)- Eg. Cattle Diet That Animal Ingest 10 To 20 Mg of Se/Kg Of BW/Day.
b. High Body Temperature.
c. Pale Mucose
d. Hoof Deformities
e. Blindness,
f. Salivation
g. Spumous and Bloody Nasal Discharge
h. Pale Mucose
i. Walking in Circle
j. Corneal Opacity, Blindness
k. Generalized muscle paralysis.

Prevention & Treatment: Avoid mineral supplements high in Se to livestock within 5miles of toxic farm unless blood sample found to be low in Se. Graze the less dangerous field. Application of sulphur containing materials. Eg. Gypsum 12 ton/acre to get Se for 1.8-2.0 mg/kg, $(NH_4)2SO_4$ 1 ton/ac to get Se for 1.0 to 1.4 mg/kg. After application of sulphur containing materials animals are not allow to graze in toxic area for more than 2 wks. Land spreading of drainage spoil should be avoided if spoil may contain high Se levels.

Conclusion

1. The heavy metals, viz., As, Cd, Pb and Hg are most toxic to all human beings, animals, fishes and environment.
2. The excess levels of heavy metals cause severe toxicity.
3. The heavy metal enters in animal either from direct or indirect sources and it contaminates the food chain of ecosystem that is dangerous for survival.
4. Mostly of the heavy metals are targeted to affect the liver, kidney and nervous system.
5. Increasing public awareness of environmental pollution influences search and development of technologies that help in cleanup of contaminants such as heavy metals.

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Insect-Based Feed Replacement in Aquaculture: Current Status and Future Prospects

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Reshma R[1], Ram Mohan[2]
[1]Ph. D. Scholar, Division of Entomology, ICAR-Indian Agricultural Research Institute, Pusa, New Delhi, 110012.
[2]Ph. D. Scholar, Division of Plant Pathology, ICAR-Indian Agricultural Research Institute, Pusa, New Delhi, 110012.

Introduction

With the rapid growth of human population and increase in standard of living, there has been a rise in demand for seafood. Due to decline in wild fish population, aquaculture gained the focus as an alternative for the demand. The aquaculture industry relies mostly on wild caught fish as aquafeed that has always been a controversial issue. 60-70% of total aquaculture production cost accounts for fishmeal or other alternatives depended on such as meat meal or soybean meal. Anti-nutritional factors in the plant-based feeds also limits its usage as aquafeed. Insect meals emerge as a promising replacement of fishmeal with its nutritional components almost equivalent to the same. On an average, substitution of fishmeal up to 30% with insect meals brought promising results in many experiments.

Insects Used in Aquafeed Production and their Nutrient Status

Insect meal production is developing rapidly in China, Europe, North America, Australia and Southeast Asian countries. Until now, at least 16 insect species have already been evaluated for an alternative protein source in aquafeeds. Out of these, 8 species were approved for the production of feed in aquaculture under EU legislation (Daniel, 2018). These include 1. Silkworms (*Bombyx mori),* 2. Black soldier fly (*Hermetia illucens),* 3. Housefly (*Musca domestica*), 4. Yellow mealworm (*Tenebrio molitor*) 5. Lesser mealworm (*Alphitobius diaperinus*), 6. House cricket (*Acheta domesticus*), 7. Banded cricket (*Gryllodes sigillatus*), and 8) Jamaican field cricket (*Gryllus assimilis*) (Fig A: 1-8).

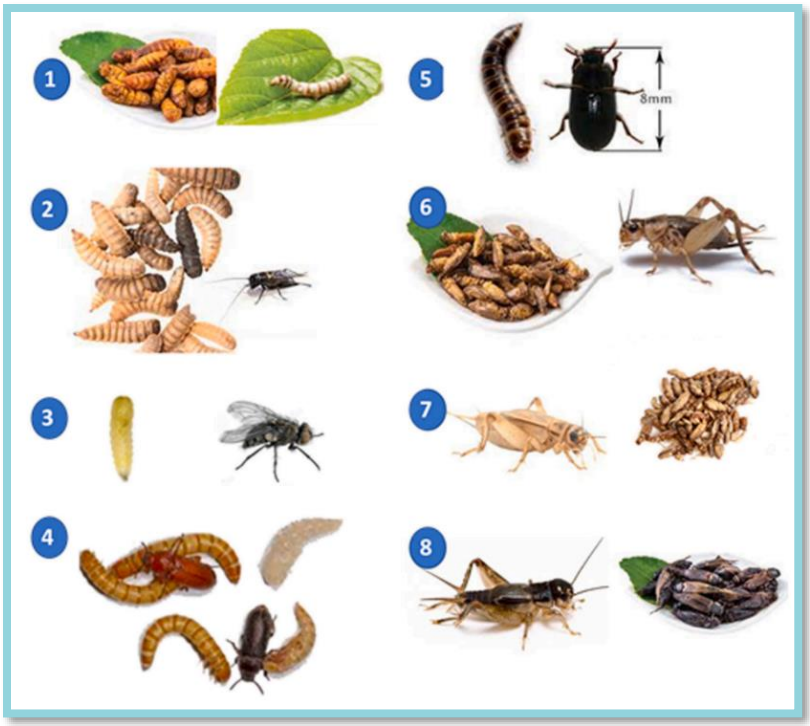

Fig A (1-8): Insects approved for the production of aquafeed

Larvae of black soldier flies and housefly possess higher crude proteins rich in lysine than others listed. Adult pupae of silkworm contain sulphur amino acids. Tryptophan content is found only in silkworm pupae and housefly maggot. The aminoacid content of silkworm, black soldier flies and housefly are superior compared to soybean meal which makes them the best alternative of fishmeal in aquafeed s (Henry *et al*., 2015). These insects are rich in polyunsaturated fatty acids (PFA), but poor in EPA and DHA content which limits their use in aquafeed as an oil source. Black soldier fly larvae contain relatively higher level of calcium and calcium/phosphorus ratio of 8.4, which makes it more preferable (suggested calcium/phosphorus ratio for fish feed: 1.1-1.4). Carbohydrate content is low in insect meal, though chitin is present, it is absorbed by selective fishes only. The nutritional components in the insect meal are depended on the substrate on which it is growing and the culture condition. Therefore., identifying the most suitable method of rearing is also important. In addition, the scarce nutrients have to be supplemented in the fish feed.

Current Status of Integration of Insects in Aquafeed

Silkworm pupa meal (SPM) has been applied in nutrition studies in aquaculture as well as ornamental fish culture in India. Feeding defatted or non-defatted SPM resulted in high digestibility in tilapia and catfish (Karthick Raja *et al.,* 2019). Positive results were reported for inclusion levels of 30–50% of defatted or non-defatted Silkworm pupae oil in feeds of Rohu (*Labeo rohita*), common carp, Mahseer putitora (*Tor putitora*) and rainbow trout (Karthick Raja *et al*., 2019). In rainbow shark (*Epalzeorhynchos frenatum*), feeding experiments revealed that SPM was able to substitute up to 30% of FM in the diet (Raja *et al*., 2020). Though SPM seems to be a good protein source to replace FM, silk worm pupa is also a good protein source for human consumption which makes it cost-competitive. Black soldier fly larva (BSFL) is a valuable insect species as insect meal. Its growth in organic matter from food and animal wastes, short life cycle, less labour-intensive rearing makes it a profitable venture. Feed trials with BSFLM on both aquaculture and aquariculture is in progress in India. Fishmeal protein substituted with 60% BSFLM improved growth performance and feed utilization in juvenile goldfish *Carassius auratus* (Kamalii *et al*., 2022) and juvenile striped catfish, *Pangasianodon hypophthalmus* (Sudha *et al*., 2022). Even 100% replacement of fishmeal with BSFLM reported successful in addressing protein scarcity, adulteration and environmental hazards in production of common carp (*Cyprinus carpio*) fry (Jahan *et al*., 2021). BSFL do not spread zoonotic diseases which makes it more preferred. The results of feeding trials with housefly maggot meal or housefly pupae meal are generally encouraging in catfish species, but maggot meal inclusion cannot exceed 30% because higher inclusion rates tend to lower growth performance. Fingerlings of *Clarias anguillaris* fed with frozen maggot larvae had the highest specific growth rate and the best mean weight.

Feeding trials in several aquaculture species proved that fresh and dried mealworms are acceptable as an alternative protein source for aquaculture. Diet containing mealworm to replace half of the FM in common catfish (*Ameiurus melas* Raf.) could maintain growth in fingerlings while fish fed with a diet containing FM grew faster than those fed with only mealworm (Roncarati *et al.,* 2015). Incorporation of 18% of mealworm meal in the diet improved the immune response and bacterial resistance of yellow catfish without affecting their growth (Su *et al.,* 2017). Lesser mealworm or litter beetle (*Alphitobius diaperinus*) has recently gained a lot of attention because it is now allowed to be used in the manufacturing of insect meal as an aquafeed element. The house cricket *Acheta domestica* used 60% with rice bran for hybrid tilapia gave best results in terms of growth and survival (Lee *et al*., 2017). Feed trials using crickets, *Gryllodes sigillatus* and *Gryllus assimilis* integrated in fish feed started recently in western countries to conclude its safety and profitability.

Conclusion and Future Prospects

Improved and profitable insect farming and processing is the backbone of insect based aquafeed. Continuous availability of quality substrate for insect rearing, suitable decontamination, drying and defatting methods has to be ensured prior to production of insect meal. The global insect protein industry is estimated to be valued at US $7.9 billion by 2030, while growing at a CAGR of over 27%. Size and scope of insect farming is also growing rapidly in India which gives a hope (Times of India., June 2022). Nutritional values of the selected insects differ among species and stages of development and none are perfect substitutes for fishmeal. Since most of the studies are around terrestrial insects, it is worthy to investigate on aquatic insect meal as an alternative for fish meal. It is also necessary to conduct research on the impact of feeding aquaculture species with insect meals on the safety, quality, and societal acceptance of seafoods. Let's hope for a green, profitable and sustainable aquaculture using insect meal wisely in aquafeed in the near future.

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Weed Management in Blackgram (*Vigna mungo* L.)

Article ID: 40703

Christinal Infanta S[1], Devi Geethika J[1], Ezhilarasi R[1], Mohamed Salman M[1], Rajagopal V[1], Sangeetha Jebalin V[1], Sriram J[1], Mini ML[2]

[1]M.Sc Scholar, Department of Agronomy, [2]Associate Professor, Department of Biotechnology, Agricultural College and Research Institute, Madurai, Tamil Nadu.

Introduction

Black gram is an important crop among the *kharif* pulses, which is usually grown in marginal and sub-marginal lands without any weed management practices. In India, Kharif black gram production during 2021-2022 was 20.5 lakh tonnes (first advance estimates) in an area of 39.43 lakh hectares. Madhya Pradesh, Andhra Pradesh, Bihar, Maharashtra, Punjab, Haryana, Tamil Nadu, Uttar Pradesh, West Bengal and Karnataka are the major black gram cultivating states in India. Black gram contains all the nutrients such as proteins, carbohydrates, fat, amino adds, minerals and vitamins. This leguminous crop has the ability to fix atmospheric nitrogen through a bacterial symbiosis which ultimately restores soil fertility. Presently, the productivity and production of the black gram are not only diminishing but the area is also reducing despite being the largest producer of black gram. Poor weed management is one of the most important factors causing yield limitation.

Major Weeds in Black Gram

Black gram is infested with different categories of weeds:

Grasses:

a. *Echinochloa spp.,*
b. *Setaria glauca*
c. *Digera arvensis*
d. *Eleusine indica*

Sedges:

a. *Cyperus rotundus*
b. *Cyperus difformis*

Broad leaved weeds:

a. *Parthenium hysterophorus*
b. *Phyllanthus niruri*
c. *Amaranthus viridis,*
d. *Trianthema portulacastrum.*

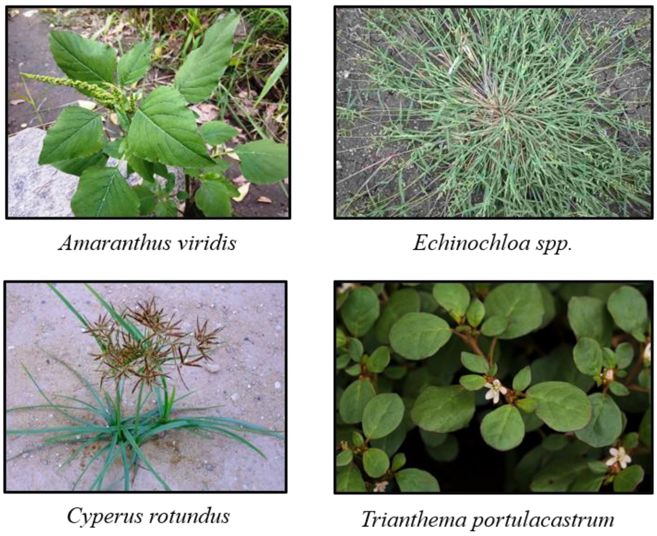

Fig.1. Major weeds in blackgram

Crop-Weed Competition

The shortest life cycle of pulse crop is subjected to crop weed competition during the critical period of its stages and results in the reduction of yield. The weeds will compete with crops for soil nutrients, light, moisture, space and water for their growth and development. The crop plants have differentiability to compete with weeds (Moolani and Sachan 2007). The critical period for weed competition in black gram is 20 - 40 days after sowing, which results in yield losses from 40-85 %. Based on the intensity and nature of weed flora, 30-50% yield reduction was observed in a study conducted at Jabalpur (Mishra and Bhanu, 2006). Black gram crop faces severe weed competition due to its slow initial growth and lack of effective control measures (Sardana *et al.,* 2006).

Weeds Control Methods in Black Gram

Weeds are controlled by various methods like cultural, manual, mechanical, biological and chemical. Manual and mechanical weeding is labor-intensive and tedious. Often laborers are not available at the peak time of requirement for weeding. Even if they are available the escalating cost of laborers further limits its option. The cultural method of weed control like the adoption of suitable crop rotation, stale seedbed method, reduced tillage and soil solarization needs long-term planning.

Chemical Method

The chemical method of weed control is not only cost-effective but also efficient in minimizing weed infestation for longer periods provided they are applied judiciously with suitable herbicide, in the correct dose and time.

1. Fluchloralin (1-1.5 kg/ha), Pendimethalin (0.5-1.0 kg/ha) as Pre emergence (pre-planting) incorporation
2. Quizalofop-p-ethyl 50 g/ha, Fenoxaprop-p-ethyl @ 625 ml/ha as Post emergence.
3. Imazethapyr at 1.0 kg/ha, oxyfluorfen @ 0.10 kg/ha as Pre and post emergence.

Integrated Approach for Weed Management

1. Pre emergence application of Pendimethalin 3.3 litres/ha under irrigated condition, 2.5 litres/ha under rainfed condition on 3 days after sowing using Backpack/ Knapsack/Rocker sprayer fitted with flat fan nozzle using 500 litres of water for spraying one hectare followed by one hand weeding at 20 DAS
2. EPOE application of quizalofop ethyl @ 50 g a.i./ha and imazethapyr @ 50 g a.i./ ha on 15 – 20 DAS.
3. For the irrigated blackgram PE Isoprotwron @ 0.5 kg/ ha^{-1} followed by one hand weeding on 30 DAS.

Conclusion

Continuous use of herbicides may cause environmental pollution and plants may lead to the development of resistance against these chemicals. Therefore, it is necessary to utilize more than one method of weed control for sustaining the productivity and profitability of crops and cropping systems.

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Vertical Farming for the Future

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K Nirosha[1], A Mamatha[1], B Ashwin Kumar[1]
[1]Assistant Professor, College of Horticulture, SKLTSHU, Rajendranagar, Hyderabad, Telangana State.

Vertical farming is the practice of growing crops in vertically stacked layers. It often incorporates controlled-environment agriculture, which aims to optimize plant growth, and soilless farming techniques such as hydroponics, aquaponics, and aeroponics. Some common choices of structures to house vertical farming systems include buildings, shipping containers, tunnels, and abandoned mine shafts.
India is a very huge country with very high population and our country is developing day by day. Indian Agriculture also needs a change with developing India. Uses of land, water and wastage also gets minimized in vertical farming. In vertical farming, crops are secured from pests and diseases, the crops are grown in a controlled environment. With these type of facilities, vertical farming is very good option for farming in the future.

Introduction

Vertical Farming is a special concept of growing food in line with indoor farming, urban agriculture and controlled agriculture environment. It is the growing of plants in vertically stacked layers. It is used where the arable land is less. Such places are mountain side towns, deserts and cities grow a different type of fruits and vegetables. In vertical farming soil, hydroponic or aeroponic growing methods can be used. Most of the common commercial vertical farms are produced inside buildings, some of them are in the green houses and shading of crops produces the unique crops.

Methods Used in Vertical Farming

In India there are three methods used in vertical farming namely Hydroponics, Aeroponics and Aquaponics. These are described as follows:
1. Hydroponics: In this method, foods are growing through water nutrients without soil. Food is secure from soil related problems such as pests, insects and diseases.
2. Aeroponics: In this method, less amount of water is used and foods are grown through moist and nutrients. As we know, in vertical farming plats are tie up with support so on their roots water nutrients are sprayed.
3. Aquaponics: This is the method of combining plants and fishes in the same ecosystem and the fish is grown inside the indoor ponds by providing them with nutrient rich waste.

Benefits of Vertical Farming

1. The main benefit of using vertical farming is every piece of land or an area is properly utilized in crop production.
2. In vertical farming, the food production can be done throughout the year. No cost of transportation is required in
3. Vertical farming When comparing with traditional farming, 70-90 % minimum water used.
4. The use of soil in vertical farming is 90% or none. So, there is no issue of pests and any type of disease.
5. Organic food production is done in vertical farming because it is free from pesticides and air pollution.

Drawbacks of Vertical Farming

1. The cost of establishment is very high.
2. Artificial light used in vertical farming which is expensive as compared to traditional farming where natural light is used.
3. Trained staff is needed in the management
4. Proper dispose of water required
5. In vertical farming LED light produces lots of heat which is a big problem in maintaining the problem during summers.

Crops Suitable

1. Some Small Size Vertical Crops: Lettuce, Broccoli, Amaranthus
2. Some Medium Size Vertical Crops: Cabbage, Cauliflower, Tomato, Brinjal
3. Some Big Size Vertical Crops: Maize, Sorghum.

Economics of Vertical Farming in India

It plays an important role in selection of crops because if the crop is biological workable and not suitable for economics then we need to leave this idea of producing that particular crop. The reason is less demand of that crop in the market, improper technique, high cost of production. So, these factors have to be considered before doing vertical farming

Vertical Farming technology is only solution to the critical problems of the Indian Farming like an absence of providing or oversupply of farm produce, excessive use of pesticides and fertilizers, weak soils and unemployment.



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Isolation, Screening, Maintenance and Improvement of Industrially Important Micro-Organisms

Article ID: 40705

Kirti Yadav[1]
[1]Department of Microbiology, Kurukshetra University, Kurukshetra, Haryana.

Introduction

The science and technology of manipulating and improving microbial strains in order to enhance their metabolic capabilities for biotechnological applications are referred to as "strain improvement" (Parekh, 2000). Today, the large-scale production of health care products, amino acids, food additives, enzymes, and antibiotics serves as testimony to the important role of strain improvement in shaping the pharmaceutical and fermentation industries (Demain and Daris, 1998).

Isolation and Screening of Microorganisms

1. An ideal strain should have the following characteristics:
   a. It should be pure and free of phage.
   b. It should grow vigorously after inoculation in seed stage vessels.
   c. The product should be produced in a short time, e.g., 3 days.
   d. Under the optimum performance conditions, the risk of contamination should be minimal.

Isolation of Microorganisms: The first step in developing producer strains is the isolation of the concerned microorganisms from their natural environment. Many different microorganisms can be isolated by using specialized enrichment techniques.

Soil treatment: UV irradiation, air drying, filtration, washings from root system, treatment with detergents, alcohols, pre-incubation with toxic agents, selective inhibitors (Anti-metabolites, antibiotics etc.), nutritional variations (specific C and N sources), variations in pH, temperature, aeration etc. The enrichment techniques are designed for selective multiplication of only some of the microorganisms. These approaches, however, take a long time (20 - 40 days) and require considerable labor and money.

The main isolation methods used routinely for isolation from soil samples are as follows –Sponging (soil directly), dilution gradient plate, aerosol dilution, floatation, and differential centrifugation.

Screening for new products:

Primary screening	Secondary screening
A set of highly selective procedures that allow the detection and isolation of microorganisms producing the desired metabolite constitute primary screening. Primary screening is time consuming and labor- intensive.	It is a systematic screening programme intended to isolate industrially important microorganisms.

Table1. Shows some valuable microorganism products that could be potential targets for targeted screening:

Product	Activity	Source
Avermectin	Antihelminthic	*Streptomyces avernitilis*
Detoxin	Antitumour	*Streptomyces olivoreticuli*
Herbicidin	Herbicide	*S. caespitosus*
Cyclosporin	Immunosuppressor	*Trichoderma polysporum*
Gibberalic acid	Plant growth regulator	*Gibberella fujikuroi*
Slaframine	Salivation inducer	*Rhizoctonia leguminicola*
Tetranactin	Miticide	*S. aureus*

Maintenance of isolates:

a. Low temperature storage at 2-6°C on agar slants.
b. Storage as lyophilized cells under vacuum at low temperature (-20 to -70°C).
c. Storage of vegetative cells in liquid nitrogen (-196°C)
d. Storage in glycerine stabs (0.85 ml of cell suspension mixed with 0.15 ml of sterile glycerol and stored at -70°C.

Strain improvement: the techniques and approaches used to genetically modify strains to increase the production of desired products are called "strain improvement". Several procedures are employed to improve microbial strains, all of which bring about changes in the DNA sequence (Parekh, 2000). Genome shuffling is a relatively new and promising technology for rapid phenotypic improvement that has received a lot of attention for phenotypic improvements of industrially important strains.((T.A. Magocha, 2018).

Benefits of strain improvement: fermentation economies are driven by the profitability of a marked product. A key component of this value is based on the manufacturing cost per unit of product (Parekh, 1999). Lower fermentation, manufacturing and capital costs can be gained from improvements in fermenter design and engineering (Doran, 1995); however, improvement of the microbial production strain offers the greatest opportunity for cost reduction without significant capital outlay (Stanbury et al., 1995). The desired result is the ability of a manufacturing process to meet this goal. Additional demands can be met without adding more production-scale fermenters or bioreactors.

Approaches for strain improvement:

a. Mutant selection
b. Recombination
c. Recombinant DNA technology.

Mutant selection is a sudden and heritable change in the traits of an organism. Mutations that occur without any specific treatment are called spontaneous mutations, while those that result from treatment with certain agents are known as induced mutations. The application of mutagens to induce mutations is called mutagenesis.

Selective isolation of mutants

a. Isolation of auxotrophic mutants: it has a defect in one of its biosynthetic pathways, so it requires a specific biomolecule for normal growth and development. Example-Phe, a glutamicus mutant, requires Phe for growth, so it accumulates Tyrosine

b. Analog-resistant mutants- it have feedback insensitive enzymes in the biosynthetic pathway.

c. Feedback inhibition: a Tyr- mutant of was chosen for resistance to P-flurophenylalanine at 50 mg/L.

d. High producers are revertants from a strain's non-producing mutants. Reversion occurs when a mutant mutates back to its original phenotype, and the mutant is known as a revertant. Example: reversion mutant of *Streptomyces viridifaciens*.

e. Selection of resistance to antibiotics - produced by the organism itself may lead to increased yield. Example: *Streptomyces aurefaciens* mutants selected for resistance to 200–400 mg/L chlortetracycline showed a 4 fold increase in the production of antibiotics.

Recombination is the formation of new gene combinations among those present in different strains. Recombination is used for both genetic analysis and strain improvement. Recombination may be based on sexual reproduction and protoplast fusion.

Recombinant DNA technology – (rDNA technology) involves the isolation and cloning of genes of interest, the production of necessary gene constructs using appropriate enzymes, and then transfer and expression of these genes into an appropriate host organism.

This technique has been used to achieve two broad objectives:

a. Production of recombinant proteins—these are the proteins produced by the transferred gene, they themselves are of commercial value. Example: Insulin, interferons, etc. are produced by bacteria.

b. Metabolic engineering—While metabolic engineering has been successfully applied to the yield enhancement of primary metabolites (Eggeling, 1998) and extracellular enzymes (Gouka et al., 1997), the overproduction of secondary metabolites is significantly more complex due to the global cellular regulation of differentiation and antibiotic production (Brakhage, 1998). Metabolic engineering occurs when an organism's metabolic activities are altered by introducing transgenes that affect enzymatic function of its cells. Examples: overproduction of the amino acid isoleucine in *glutamicum* and ethanol by *E.coli*.

Applications

1. Large scale production of vaccines, enzymes, interferons, growth factors and blood clotting factors.
2. In the field of microbiology, improve the microbe's productivity.
3. Treatment of genetic diseases like SCID by rDNA technology.

Conclusion

The task of both discovering new microbial compounds and improving the synthesis of known ones have become more and more challenging. The tremendous increase in fermentation productivity and resulting decrease in costs have come out mainly by using mutagenesis. In recent years, recombinant DNA technology has also been applied.

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DNA Methylation and its Role in Seed Development

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M. Hemalatha[1]
[1]Ph.D Scholar, Department of Seed Science and Technology, AC, Dharwad, UAS, Dharwad – 580005.

Introduction

As DNA purification strategies improved, it appeared that at least some of our genome was bonded with small alkyl groups consisting of three hydrogen atoms attached to a carbon. These methyl groups would eventually be found in bacteria, viruses, plants, and animals—across all life—but what did they do? How did we come to appreciate DNA methylation? DNA modification in different cells/tissues is dynamically regulated during plant growth, development, and under varying environmental conditions. This indicates the important roles of DNA modifications in the regulation of gene expression and physiology.

Epigenetics

The word epigenetics means "above" or "on top of" genetics which refers to external modification to DNA that turns genes "on" or "off". These modifications do not change the DNA sequence, but instead, they affect how cells "read" genes. It refers to heritable changes in gene expression that does not involve changes to DNA sequence: a change in phenotype without a change in genotype.

History

In 1942, the term "epigenetics" was introduced by embryologist Conrad Waddington. In 1948, DNA methylation was discovered in mammals as early as DNA was identified as the genetic material by Rollin Hotchkiss. In 1952, discovered in bacteriophage, in mammalians in 1970 and proved in 2009.

DNA Methylation

1. DNA methylation is a biological process by which methyl groups are added to the DNA molecules.
2. When located in a gene promoter, DNA methylation typically acts to repress the gene transcription.

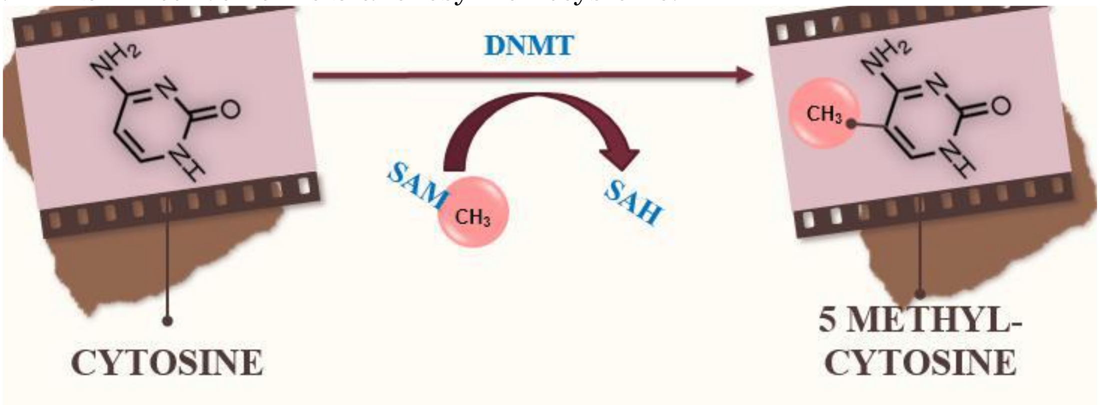
DNA Methylation Results in 3 Types of Methylated Bases

C5-methylcytosine
N4-methylcytosine
N6-methyladenine

a. It occurs in the cells of fungi, plants, non-vertebrates and vertebrates.
b. In vertebrates 3 to 6% DNA cytosine is methylated.
c. No methylation in many insects and in single celled eukaryotes
d. In plants 30% DNA cytosine is methylated.

Mechanism

Methyl groups are transferred from S-adenosyl methionine in a reaction catalyzed by a DNA methyl transferases. And SAM converted to S-adenosyl homocysteine.



Where it Occurs?

In mammals: Regions of CpG islands.

In Plants: Symmetric CG and asymmetric CHH and CHG sequences

Enzymes involved in DNA methylation: The addition of methyl groups is controlled at several different levels in cells and is carried out by a family of enzymes called as DNA methyltransferases. They can be classified as:

a. **In mammals** DNMT 1 and DNMT 3a, 3b: DNMT 1: maintains DNA methylation after replication. DNMT 3a and 3b: De novo methylation.

b. **In plants** MET, CMT & DRM: MET (Methyltransferase) – CG, CMT (Chromomethyltransferase) - CHG, DRM (Domain rearranged methyltransferase) – CHH.

Detection Methods for DNA Methylation

Bisulphite sequencing: Sulfite can be reversibly added to mediate deamination of cytosine to uracil.

Restriction enzyme analysis: The restriction endonucleases are enzymes which recognize and cleave the DNA at a specific sequence. There are restriction endonucleases that recognize the same sequence of DNA but one of them is sensitive to cytosine methylation which means that it fails to cleave the DNA if methylated, while the other cleaves the DNA irrespective of whether the DNA sequence is methylated or not. One such pair of enzymes is HpaII and Msp I; both recognize CCGG sequence but HpaII will not cleave if the second cytosine residue in the sequence is methylated. Such enzyme pairs are used effectively to obtain overall differences in methylation between two DNA samples. The cleavage is followed by amplification of the region by polymerase chain reaction. If the region is methylated, it is not cleaved and, hence, amplified, thus indicating gene repression.

Role of DNA Methylation in Plants

1. **Regulation of gene expression**: to differentiate cells/tissues.

2. **Transposon silencing**: Active TEs threaten genome stability/integrity due to the jumping of transposons or repeated insertion of retrotransposons. Any loss of methylated CHH island leads to transcriptional activation of the transposon, suggesting that RdDM is needed to keep the transposons silenced. Transposon containing in euchromatic regions in *Arabidopsis* are hypermethylated in all cytosine contexts

3. **Genomic imprinting**: it is a process of silencing genes through DNA methylation. The repressed allele is methylated, while the active allele is unmethylated. While the allele from one parent is expressed, the allele from the other parent is silenced. This is known as genome imprinting. In flowering plants, megaspore mother cell (MMC) undergoes meiosis to form female reproductive organs. Similarly, the microspore mother cell (MiMC) undergoes meiosis to form male reproductive organs. Both MMC and MiMC undergo large-scale chromatin changes, including heterochromatin decondensation, during cell specification indicating a highly active transcriptional activity. Recently, DNA methylation was profiled in the MiMC of *Arabidopsis*, wherein high levels of CG and CHG methylation but low level of CHH methylation were reported.

4. **Seed development** is an essential process for seed quality and productivity. During seed development in soybean, CHH methylation was reported to increase from 6% at the early stage to 11% in the late stage.

5. **Tolerance to abiotic stress**: Abiotic stresses have been reported to cause alterations in DNA methylation in plants. Important roles in the adaptation of plants to the changing global climate. Studies on abiotic stresses indicate stress-induced DNA (de)methylation of stress-associated genes.

6. **Tolerance to biotic stress**: In addition to the abiotic stresses, plants are also challenged by various biotic stresses like insect pests and diseases. Several studies have established the role of epigenetic variations in plant-microbe interaction mainly through gene regulation

7. **Stress memory and adaptation**: It has been shown that plants can remember past environmental stress and use the memories to respond rapidly to the stress when it recurs.

Role of DNA Methylation During Reproductive/Seed Development (Kumar and Mohapatra, 2021)

During male gametogenesis in pollen, the transposons in the vegetative cell are de-silenced due to DNA demethylation by Demeter (DME) and by downregulated expression of Decreased DNA Methylation 1 (DDM1, a chromatin remodeler). Transposon-generated transcripts are converted into siRNAs, which enter into the sperm cells and cause silencing of transposon through DNA methylation. On pollination, one of the sperm cells fertilizes a female gamete (central cell) and forms the endosperm, wherein reinforced CHH methylation at transposons (in the male genome) and DME-mediated global DNA demethylation (in the female genomes) are observed. Another sperm cell fertilizes the egg cell to form an embryo, where reinforced CHH methylation in the male genome but domain rearranged methylase 2 (DRM2) and RNA polymerase V (Pol V) derived RdDM pathway in the female genome are observed. Thus, manipulation in genome imprinting through epigenome editing might help to develop a superior endosperm for improvements in seed crops.

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The Stingless Bee Queens, from Egg to Adult

Article ID: 40707

Katta Subramanya Sai Teja[1], Dr. Nagendra Kumar[1]
[1]Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar.

Introduction

The stingless bees are a family of highly eusocial bees that are indigenous to tropical and subtropical areas of the world (Hymenoptera: Apoidea: Meliponini). With an estimated 550 species belonging to 58 genera, they are the most diverse group of social bees. According to Rasmussen and Cameron (2010), these are divided into three monophyletic clades: Neotropical, African, and Indo-Malayan-Australasian, which diverged from one another 50–70 million years ago. The Neotropics are home to the majority of the species diversity (>400 species). Female workers forage for food, guard the colony from predators, and take care of the queen's brood in stingless bee colonies, where the queen is the only reproductive female capable of laying female (diploid) eggs.

Stingless bee colonies depend heavily on their queens. In a colony, only one queen typically exists at any given time, and she controls egg production. They ensure the growth and survival of these matriarchal societies and keep the colony cohesive. However, compared to the life cycles of their daughters, the workers, there are still sizable gaps in our understanding of the queens. In this review, we trace the development of queens chronologically, beginning with their pre-emergence in brood cells (caste determination), moving on to their interactions with workers (queen selection), men (sexual selection), and finally to adulthood. It is possible to identify stingless bee queens either tropically or genetically. The virgin queens go through a selection process after emergence, during which many are killed by workers. Queen selection may be influenced by a virgin queen's body type, pheromones, age, and behavior.

The queens then depart the nest for their one-time mating nuptial fight. After mating, queens are still susceptible to workers' harassment. For instance, workers kill them if they produce diploid males. Previous studies have successfully in vitro reared and mated virgin queens under laboratory conditions, which have revealed new insights of queen development time, the threshold of minimum and maximum provided food to larvae develop ing into queens, and lethal and sublethal effects of agrochemical substances. New knowledge about the physiology of queens has also been made available by these new techniques.

Queen Production

In stingless bees, new queens can be chosen either trophically (where any female larvae that are raised in larger brood cells and, consequently, receive more larval food than the larvae in regular brood cells, will develop as queens) or genetically, as in the *Melipona* genus (although there is a slightly plastic ratio, which is afected by nutritional conditions) (Fig. 1a–e). Also, certain stingless bee species (such as *Frieseomelitta varia*) have larvae that are raised in worker cells that can pierce auxiliary cells and eat extra food there before growing into queens (Fig. 1F). Typically, stingless bee queen and worker castes can be distinguished physically, morphologically, and behaviorally. Nonetheless, mature female bees have been seen to occasionally have both corbiculae and spermatheca, making them intercastes. Uncertainty surrounds the cause of the intercaste condition.

In some species, as *Nannotrigona testaceicornis*, *Plebeia remota* and *Schwarziana quadripunctata*, alternative queen phenotypes, known as dwarf or miniature queens, may also occur and head new colonies. The idea that female larvae in social insects should, in some circumstances, beable to decide their own developmental fate is supported by the existence of miniature queens. This suggests that larvae raised in brood cells that were intended to develop into workers could use a self-sh technique to avoid the worker fate and instead turn into tiny queens (Wenseleers et al. 2005; Ribeiro et al. 2006).

A substance consumed by female larvae has been known to be a factor afecting caste determination of *Melipona* genus, in which queens are genetically determined. It was suggested that a cohort of adult bees (nurse workers) could apparently coerce female larva to become queens by adding geraniol to larval food (Jarau et al. 2010). Geraniol is also present in pollen from various plant species, and according to van

Veen's (2018) hypothesis, the short-term, relatively high-volume collection of fresh pollen during gyne production in *Melipona beecheii* colonies may serve as a natural regulatory mechanism that restricts the overproduction of virgin queens to times of swarming and supersedure. On the other hand, subsequent research re-examined these ideas by artificially raising the quantities of geraniol in female larvae feeding, and the results showed that the substance had no effect on the development of new queens.

The majority of stingless bee species (other than those belonging to the Melipona genus) depend on food availability to determine caste. According to investigations, there is a minimum amount of larval food offered to female larvae below which the larva transforms into a worker. The development of all female larvae into queens, on the other hand, results from amounts of the same larval diet beyond this threshold and within a larger brood cell called the royal cell. On general, at least twice as much larval food is supplied to potential queens as it is to potential workers (Table 1). Given that only big males have been seen to date sprouting from royal cells, this seems to guarantee that only queens will arise (references in Table 1). Eggs deposited into worker cells can also mature into standard-sized queens in some stingless bee species with castes that are trophically determined.

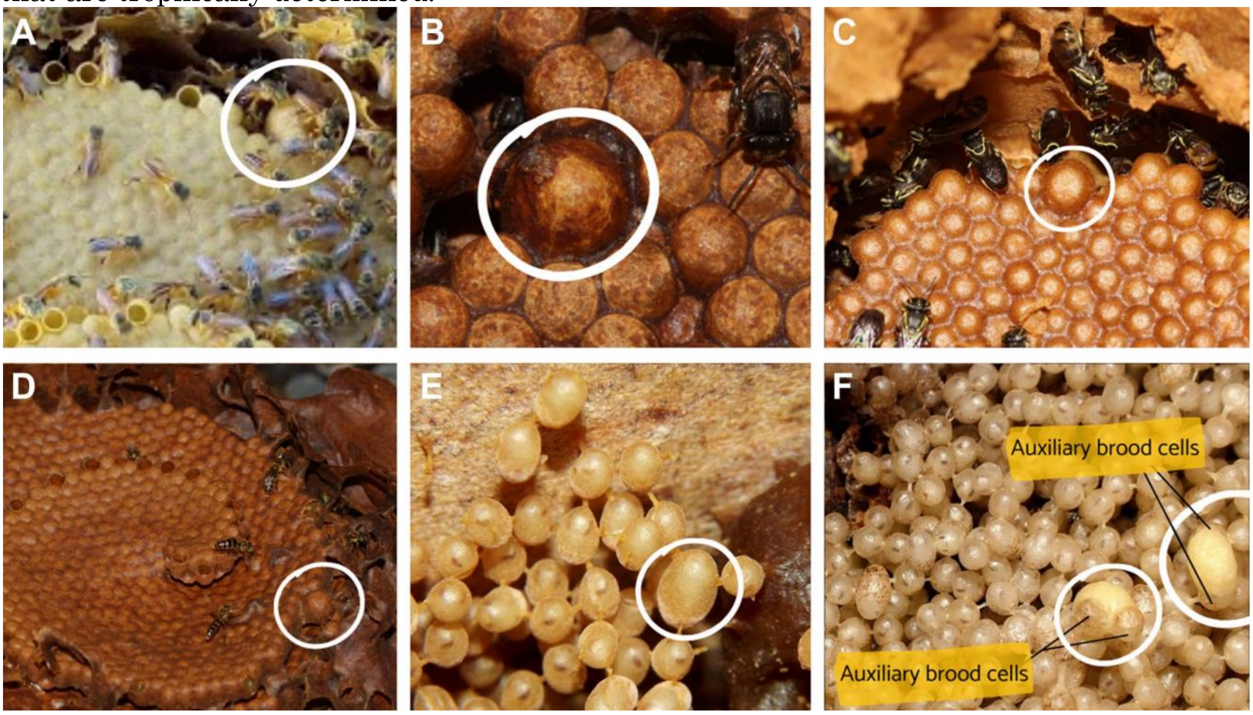

Fig. 1 Royal brood cells (white ellipses) of some stingless bee species on: horizontal (disc-like) brood combs of A *Tetragonisca angustula*, B *Scaptotrigona af. depilis* and C *Paratrigona subnuda*; Spiral brood comb of D *Tetragona clavipes* and clustered brood cells of E *Plebeia minima* and F *Leurotrigona muelleri*.

In order to consume the extra food that is kept there, female larvae may reach either auxiliary cells (lacking larva) or neighbouring brood cells (carrying eggs or young larvae) (*Frieseomelitta varia*, *Leurotrigona muelleri*, *Plebeia lucii*, and *Tetragonula carbonaria*). This can be regarded as an emergency queen production mechanism when it takes place in orphaned colonies. For instance, *Tetragonula carbonaria* colonies that are producing new queens build royal cells, while colonies that are not producing new queens only build auxiliary cells (Nunes et al. 2015). On the other hand, in *Leurotrigona muelleri*, larvae can themselves perforate neighbouring brood cells (containing eggs, or young larvae) and consume their food content, turning into a new queen.

Two characteristics of this unique instance of queen emergence are present in all species where it has been observed to date: (i) the fusion of two neighboring cells, and (ii) the absence of males emerging from those merged cells. Workers may distinguish brood cells with female larvae and disregard those with male larvae when creating auxiliary cells to raise emergency queens. However, to date there is no information on whether specific larvae are chosen at the cost of another or even if such larvae emit any type of signal to be chosen. Male larvae may also abstain from perforating their own adjacent cells because, presumably, there is no fitness benefit to being a "giant male," even when female larvae do so. The presence of those large males is observed in a number of species, both rarely (Tetragonula carbonaria; Gloag et al., 2007) and frequently (*Friesella schrottkyi*, *Paratrigona subnuda*, *Plebeia droryana*, *P. emerina*, *P. remota*, *Scaptotrigona postica*, *Schwarziana quadripunctata*). The ability of these males to fertilize queens has not yet been determined, despite the fact that they develop more slowly and generate more sperm cells.

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Impact of Climate Change on Livestock

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Vishal D. Wale[1], J. D. Jadhav[1], V. T. Jadhav[2]
[1]Department of Agricultural Meteorology, College of Agriculture, Pune.
[2]Agrometeorologist, Zonal agriculture research station, Solapur.

Introduction

Climate change is a threat to livestock production because of the impact on quality of feed crop and forage, water availability, milk production, diseases, reproduction, and biodiversity. Livestock production will be limited by climate variability as animal water consumption is expected to increase by a factor, demand for agricultural lands increase due to need for 70 per cent growth in production, and food security concern since about one-third of the global cereal harvest is used for livestock feed. Livestock play a major role in the agricultural sector in developing nations, and the livestock sector contributes 40 per cent to the agricultural GDP. The potential impacts on livestock include changes in production and quality of feed crop and forage, water availability, animal growth and milk production, diseases, reproduction, and biodiversity. These impacts are primarily due to an increase in temperature and atmospheric carbon dioxide concentration, precipitation variation, and a combination of these factors. Temperature affects most of the critical factors for livestock production, such as water availability, animal production, reproduction and health. Forage quantity and quality are affected by a combination of increases in temperature, CO_2 and precipitation variation.

Climate change can adversely affect productivity, species composition, and quality on forage production. Due to the wide fluctuations in distribution of rainfall in growing season the forage production will be greatly impacted. The climate change influences the water demand, availability and quality. Changes in temperature and weather may affect the quality, quantity and distribution of rainfall, snowmelt, river flow and groundwater. Climate change can result in a higher intensity precipitation that leads to greater peak run-offs and less groundwater recharge. Longer dry periods may reduce groundwater recharge, reduce river flow and ultimately affect water availability, agriculture and drinking water supply. Emerging diseases including vector borne diseases that may arise as a result of climate change will result in severe economic losses Livestock are adversely affected by the detrimental effects of extreme weather. Climatic extremes and seasonal fluctuations in herbage quantity and quality will affect the well-being of livestock, and will lead to declines in production and reproduction efficiency (Sejian, 2013).

Impact of Climate Change on Livestock Growth

Animals exposed to heat stress reduce feed intake, efficiency of feed conversion, weight gain, body weight, average daily gain, body condition of livestock and increase water intake. Sodium and potassium deficiency under heat stress may induce metabolic alkalosis, increasing respiration rate.

Impact of Climate Change on Feed Quantity and Quality

The quantity and quality of feed will be affected mainly due to an increase in atmospheric CO_2 levels and temperature. Changes in temperature and CO_2 levels will affect the composition of pastures by altering the species competition dynamics due to changes in optimal growth rates. Quality of feed crops and forage may be affected by increased temperatures and dry conditions due to variations in concentrations of water-soluble carbohydrates and nitrogen. Temperature increases may increase lignin and cell wall components in plants which reduce digestibility and degradation rates leading to a decrease in nutrient availability for livestock. A decrease in forage quality can increase methane emissions per unit of gross energy consumed. Therefore, if forage quality declines, it may need to be offset by decreasing forage intake and replacing it with grain to prevent elevated methane emissions by livestock.

Impact of Climate Change on Livestock Production

Animals exposed to heat stress reduce in the milk yield and milk quality, reduced fat content, lower chain fatty acids, solid nonfat, lactose contents and increased palmitic and stearic acid contents. The higher production animals are more sensitive to the heat stress. Heat stress reduce water loss from urine in goat, reduce milk production due to change in pulse, respiration and rectal temperature. Heat stress reduce body size, carcass weight and fat thickness in ruminant in meat production animal. It reduces growth, carcass weight and feed intake in pig production. It reduces body weight grain, feed intake, carcass weight, protein and muscle content in birds. Heat stress on hens will reduce reproduction efficiency and egg production because reduced feed intake and interruption of ovulation. Egg quality such as weight, shell weight and thickness also affected.

Impact of Climate Change on Livestock Reproduction

The reproductive processes are affected by thermal stress. Conception rates of dairy cows may drop in summer, and heat stressed cows often have poor expression of oestrus due to reduced oestradiol secretion from the dominant follicle developed in a low luteinizing hormone environment. Reproductive inefficiency due to heat stress involves changes in ovarian function and embryonic development by reducing the competence of oocyte to be fertilized and the resulting embryo. Heat stress compromises oocyte growth in cows by altering progesterone secretion, the secretion of luteinizing hormone, follicle-stimulating hormone and ovarian dynamics during the oestrus cycle. Heat stress has also been associated with impairment of embryo development and increase in embryonic mortality in cattle. Heat stress during pregnancy slows growth of the foetus and can increase foetal loss. Secretion of the hormones and enzymes regulating reproductive tract function may also be altered by heat stress. In males, heat stress adversely affects spermatogenesis perhaps by inhibiting the proliferation of spermatocytes, lower sperm concentration and quality.

Impact of Climate Change on Livestock Adaptation

Animals in heat stress initiate compensatory and adaptive mechanisms to re-establish homeothermy and homeostasis to maintain body temperature within physiological limits, which are important for survival, but may result reduction in productive potential. The relative changes in the various physiological responses *i.e.* respiration rate, pulse rate and rectal temperature give an indication of stress imposed on livestock. The thermal stress affects the hypothalamic-pituitary-adrenal axis. Corticotrophin releasing hormone stimulates somatostatin, possibly a key mechanism by which heat stressed animals have reduced growth hormone and thyroxin levels.

Impact of Climate Change on Livestock Disease Occurrences

Variations in temperature and rainfall are the most significant climatic variables affecting livestock disease outbreaks. Warmer and wetter weather will increase the risk and occurrence of animal diseases, because certain species that serve as disease vectors, such as biting flies and ticks, are more likely to survive year-round. The movement of disease vectors into new areas e.g. malaria and livestock tick borne diseases (babesiosis, theileriosis, anaplasmosis), rift valley fever and bluetongue disease. Certain existing parasitic diseases may also become more prevalent, or their geographical range may spread, if rainfall increases. This may contribute to an increase in disease spread for livestock such as ovine chlamydiosis, caprine arthritis, equine infectious anemia, equine influenza, marek's disease, and bovine viral diarrhea. Outbreaks of diseases such as foot and mouth disease or avian influenza affect very large numbers of animals and contribute to further degradation of the environment and surrounding communities' health and livelihood.

Conclusion

The direct impact of climate change on livestock production comes from the heat stress. Heat stress results in a significant financial burden to livestock producers through decrease in milk component, milk production, meat production, reproductive efficiency and animal health. The indirect impacts of climate change largely through reductions or non-availability of feed and water resources. Climate change has the potential to impact the quantity and reliability of forage production, quality of forage, water demand for cultivation of forage crops and vegetation patterns.

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Feeding of Livestock Under Scarcity Condition

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Dr. Dilip Deokar[1], Abasaheb K. Parade[2], Pranjali B. Meshram[2]
[1]Senior Scientist, Research cum development Project on Cattle, MPKV, Rahuri.
[2]Ph.D. Research Scholar, Department of Animal Husbandry and Dairy Science, MPKV, Rahuri.

Introduction

Scarcity of feed resources is a common problem limiting the animal production. Various natural calamities like floods, droughts and cyclone produces scarcity of foods and feeds. Among all, flood is the major devastating natural calamity leading to a heavy loss of vegetation.

Different kinds of damages caused by floods can be categorized as follows:
1. Loss of standing crops due to submerging in flood water.
2. Damage of stored dry roughage due to water soaking followed by fungal growth causing loss of digestible nutrients.
3. Washing away of dry roughage stored in open space by aggressive currents of flood water.
4. Damage of stored food grains by water soaking followed by fungal growth resulting in loss of nutrients and production of harmful/toxic metabolites.
5. Pollution of water with dung, urine, debris and other wastes.

Feeding strategies during scarcity depend on the specific conditions prevailing in any particular area. In general the farmer has to make decisions based on economics, knowledge of nutrition, the availability of feed resources and his calculated guess on the length of the drought.

Feeding Technologies to be Used During and After Flood

1. Complete feed blocks
2. Urea molasses mineral block licks
3. Urea treatment of straws
4. Use of dry and fallen tree leaves
5. Use of conventional and unconventional feeds

Complete feed block (CFB): Complete feed block is composed of forage, concentrate and other supplementary nutrients in desired proportions capable to fulfil nutrient requirement of an animal. The CFBS can be used during flood situations due to easy transport.

The blocks have dimension of 0.5 cubic feet containing about 13% proteins and 50 to 55% total digestible nutrients. The nutritive value is 33% higher than common feed. The machine costs about 3.5 lakhs.

Advantages of Complete Feed Blocks: The blocks can be prepared in the surplus season and can be fed during scarcity and or transported to the deficit region for feeding of animals to save heavy loss of livestock. Different types of feed block i.e., for maintenance, growth and lactation can be formulated.

Major advantages of complete feed block are:

a. Balanced and adequate intake of concentrate and roughage for better animal production.
b. Prepared feed blocks require one third space as compared to mash form.
c. Reduced loss of valuable dry matter, as left over feed/ wastages.
d. The palatability, voluntary intake and nutrient utilization of low-grade roughage are increased.
e. Transportation of such blocks is easier and trouble free.
f. May be used as a carrier of several chemicals and prophylactic medicines.

Urea molasses mineral block licks: The urea molasses mineral block (UMMB) is a strategic feed supplement for ruminant animals. Molasses, urea and other ingredients are used in the manufacture of molasses/urea feeds that are prepared as blocks. They can also include specific components.

a. Urea, which provides fermentable nitrogen, is the most important component of the block. Urea may increase the Intake of straw and other low quality forages as well as their digestibility. The Intake of urea must be limited to avoid toxicity problems but sufficient to maintain ammonia levels in the rumen consistently above 200 mg N/1 for growth of microorganisms in the rumen and high rates of degradation of fibre.
b. Wheat or rice bran has a multiple purpose in the blocks. It provides some key nutrients including fat, protein and phosphorus. It also acts as an absorbent for the moisture contained in molasses and gives structure to the block.
c. Minerals may be added where appropriate. Common salt is generally added because this is often deficient in the diet and it is cheap. Calcium is supplied by molasses and by the gelling agent, calcium oxide or cement.
d. A binder is necessary in order to solidify the blocks. Various products have been tried successfully: magnesium oxide, bentonite, calcium oxide, calcium hydroxide and cement. The use of cement has raised questions about possible negative effects on animals. Research on the use of cement or its by-product, cement kiln dust, as a mineral supplement have not shown adverse effects at levels of 1 to 3 per cent of the total diet dry matter. However, the USDA has restricted the use of cement kiln dust since it could cause a deposit of heavy metals in animal tissue.
e. Various chemicals or drugs for the control of parasites or for manipulation of rumen fermentation can be added to the molasses blocks which can be an excellent carrier for these products.

UMMB developed by different private and government agencies are very helpful in saving life of animals during scarcity, NDDB, Anand developed such licks containing Urea 15%, molasses 45%, mineral mixture 15%, cotton seed cake 10%, salt 8% calcite powder 4% and sodium bentonite 3%.

Urea treatment of straws: Potential sources of feeds for small livestock are by-products from both arable crops and agro-industrial processes. These can be valuable sources of nutrients for livestock, rich in both protein and energy. However, they are often low in nutritive value but rich in anti-nutritive factors. Many of the crop by-products (such as straws and stovers) are also extremely fibrous and more suitable for feeding to large ruminants (such as cattle and buffalo) rather than sheep and goats.

There has been a considerable amount of work done on the urea treatment of straw. The recommended treatment rate is 40 g urea/kg straw with the urea usually being added as a solution in water (40 g urea/l water) which is then sprinkled on the straw.

The straw may then either be fed straight away, or ensiled to enable the urea to degrade the fibre to some extent. If the urea treated straw is fed straight away, then straw digestibility is increased by about 5 units, whereas if it is ensiled for ten days, the increase in digestibility is twice this.

It should also be noted, when using this technology to Improve the feeding value of straw for goats, that goats are extremely susceptible to urea toxicity and will die from urea toxicity at much lower dose rates than is the case with large ruminants such as cattle and buffalo. It is therefore important that if straw is treated with urea, the urea solution is dispersed Besides common fodder, shrubs and herbs like pipal, neem, mango, kathal, etc, other non-toxic tree leaves may also be fed to farm animals to supply part of their nutritional requirements.

The availability of digestible protein for most of the green tree leaves is limited to 1-2% and energy equivalent to 10-15% of total digestible nutrients, on fresh basis containing about 15% dry matter. They are potential sources of much needed carotene, the source of vitamin A activity.




Use of conventional and unconventional feeds: The different kinds of conventional and unconventional feed stuffs for the preparation of rations of different categories for feeding of flood affected animals been listed below:

<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>Pasture Grasing</td><td>Fiber Crops</td><td>Roughages</td><td>Tree Leaves</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">Dry fodder crops</td><td colspan="2">Oil Cakes</td></tr>
</table>

a. Crop residue: Rice is the staple food for the people, the farmers of all the state cultivate paddy as the main cereal crop. After harvesting the grain from the crop, the left portion is known as straw. These straws are collected from the field by the farmers and stored after drying in big stock for

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feeding of animals. Paddy straw constitutes the basal roughage of cattle and buffaloes in different north eastern states of India. It is usually stored on wooden or bamboo platform raised over the ground. This is required to minimize spoilage in the heavy rainfall areas.

b. Sugarcane crop residue: Sugarcane is cultivated in some part of India. After harvesting the sugar cane, the green tops available as a waste can be used for the feeding of cattle and buffaloes. Some quantity of cane tops is converted into hay at some places, while good quantity of it goes waste, which can be preserved by ensiling. Sugarcane trash mostly used as fuel for the preparation of jaggery, may also be used to supply part of the roughage requirement after chaffing and enriching with more palatable and nutritious feeds. Bagasse is available in sugar factories and crushers after extraction of juice. A small quantity is also available with farmer during the process of jaggery preparation. Parity large proportion of bagasse is used as source of energy in the form of fuel for boilers. The palatability and nutritional value of bagasse for the livestock (cattle and buffaloes) are much better than the rice hull available from the huller rice mills and the latter may be used as fuel saving the former for the Feeding in need during scarcity period.


c. Aquatic plants: Several types of aquatic plants are available in river, pond and other water logging areas may be used for the feeding of farm animals. Although the palatability of most of the aquatic plants is not good but the voluntary intake often exceeds 1kg dry matter per 100 kg body weight in cattle and buffaloes. Besides supplying protein and energy they are rich sources of carotenes.




So far, the common aquatic plants tested for the feeding of farm animals are water hyacinth, aquatic spinach, stalks and leaves of lotus plant (*Neumbull sp.*), water chestnut (*Trapa natana*), hydrilla, pistia, aquatic weeds and. They are available readily at most of the places during floods, which can be used in different forms for feeding of animals during scarcity.

Post Flood Feeding Management

1. Animals should not be allowed to graze in water logged areas.
2. Feeds to be protected from fungal contamination and wet feeds to be dried and fed.
3. Provide clean drinking water to animals. 40-50g of salt per adult animal and 10-20g for small ruminants and calves to be provided daily through feed.
4. Attempts need to be made to provide ready to eat feed blocks particularly to the pregnant and lactating animals.
5. Requirement of energy may be met by providing crude molasses.
6. Top feeds/tree leaves available in the area be provided to meet the dry matter requirement.

Planning for Feeding of Flood and Drought Affected Animals

Keeping in view of food and drought situations, there is a need to establish feeds and fodder banks at non-affected areas. Ministry of Agriculture and Cooperation has a scheme with the name of Gramin Bhandaran Yojana. Similar programmes may be proposed for feeds and fodder to encourage farmers to contribute in such banks. These banks are necessary to meet the emergency needs of livestock during floods and other natural calamities.

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Insect Pest of Banana and their Management

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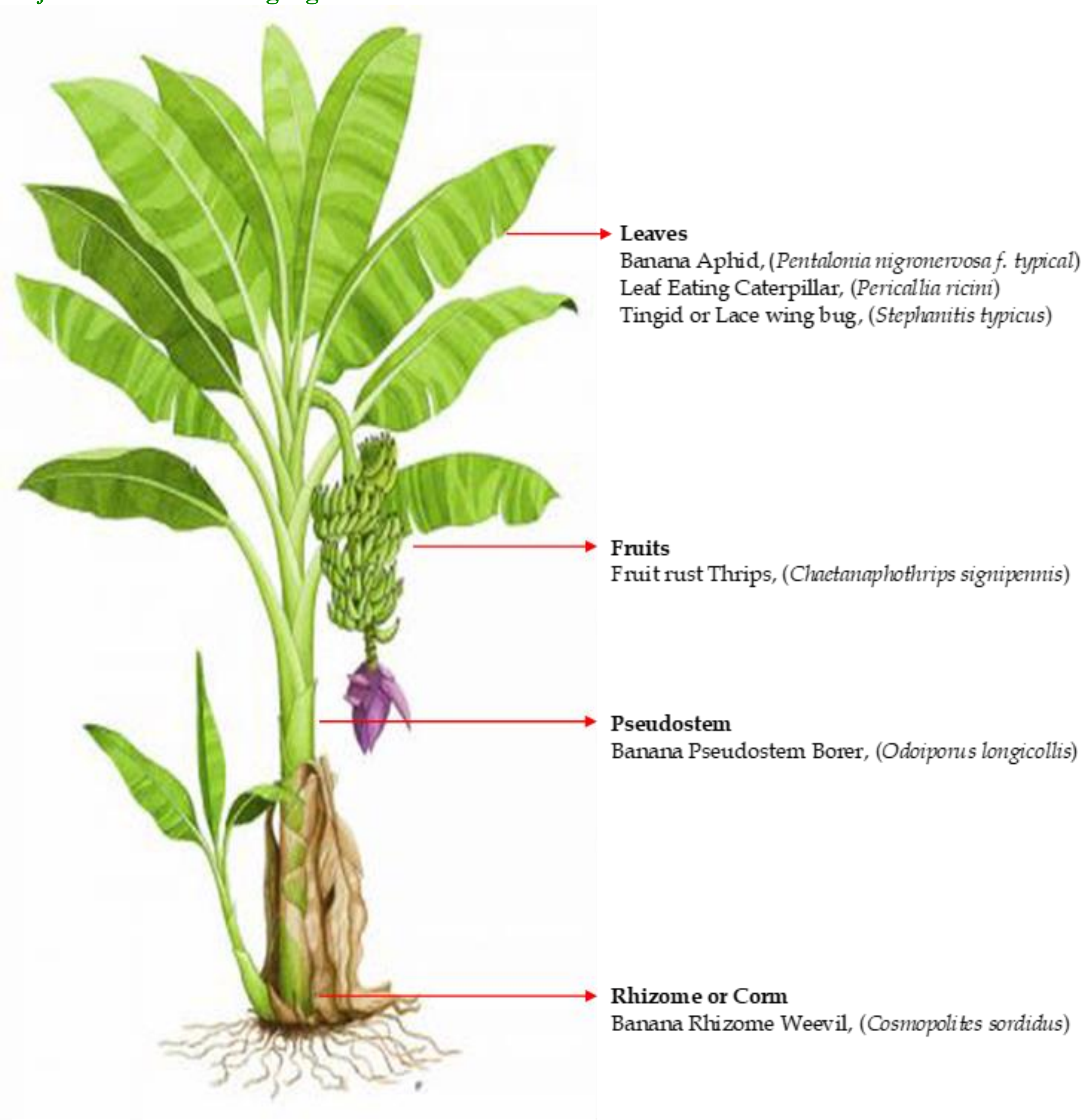
Padhiyar, D. H.[1], Chaudhary, D. V.[1], Thakar P. K.[1]
[1]Ph. D. Scholar, Department of Entomology, S. D. Agricultural University, Sardarkrushinagar, Dantiwada, Banaskantha, Gujarat – 385 506.

Major Pest and Damaging Site of Banana



Banana Rhizome/ Corm Weevil

(*Cosmopolites sordidus*, Germar)
Coleoptera: Curculionidae
Pest status: major pest of banana.
Also known as the **banana beetle and banana borer**.
Distribution: Native South East Asia, also covers parts of Australia, the Hawaii Island, tropical and South Africa and tropical America.
Host Range: Banana, Cocoa

Mark of Identification:

a. **Eggs** - laid singly, white in colour, present on the upper part of rhizome.
b. **Grub** - apodous, yellowish white with reddish brown head.
c. **Pupa** - white in colour, occur in inside the corm and tunneling.
d. **Adult** - dark weevil, newly emerged weevil is red brown, and have prominent snout on anterior part of head.

		
Grub	**Pupa**	**Adult**

Nature of Damage:

a. Damage occur beneath the soil surface.
b. Damaging site is underground rhizomes.
c. Damage cause by tunneling in the rhizomes.
d. Due to damage to the vascular bundle by grub, nutrient flow is arrested and yellow lines on the top leaves observed.
e. In advance stage, plant show tapering of the stem at crown region, reduction in leaf size, poor bunch formation due to grub damage in corms.
f. Due to tunneling of the larvae in the corn, thus weakening the plant and causing drop down by even slight winds.
g. Adults feed on dead or dying banana plants and live under newly cut or rotting pseudostems. The female weevil either lays its eggs in the rotting pseudostem.

Life History:

a. **Metamorphosis**: Complete
b. **Site of Oviposition**: In Corm, 10-50 elongate, oval, white eggs, hatch in 5-8 days.
c. **Larval Stage:** Feed in corm, full grown within 2-4 weeks.
d. **Pupation**: In the tunnel made in corm, white in colour last for 1 week.
e. **Adult:** Remain in soil feeding on underground parts of plants. Live for one year.

Management:

a. Select healthy sucker and plant, care to avoid presence of eggs.

b. Do not take regular crop in the same field to avoid initial infestation.
c. Removal of pseudo stems below ground level.
d. Grow less susceptible varieties.
e. Use cosmolure trap at 5/ha.
f. Keep Cleanliness in the field, as adult feed on the plant part.
g. For killing the active stages of weevil, give hot water treatment of banana rhizomes at 55^0 C for 5 to 10 minutes before planting.
h. Regular monitoring of weevil by keeping banana traps viz. longitudinal cut stem trap of 30 cm size @ 10-15 per acre.
i. Place longitudinal split banana traps @ 100 ha with bio control agents like entomopathogenic fungus *Beauveria bassiana* or entomopathogenic nematode, *Heterorhabditis indica* @ 20 g/trap.
j. Application of Phorate or carbofuran @ 5 to 10 gram per plant in the pit prepared for planting as grub damage to underground portion.
k. In case of post-planting infestation, spray the pseudostem and drench around the base of the tree with Chlopyriphos 20 EC @ 2.5 ml/l.
l. Cut the banana plant after harvest at the ground level and treat it with carbaryl (1g/liter) or chlorpyriphos (2.5 ml/lit) at the cut surface.

Split Banana Trap

Banana Pseudostem Weevil

(*Odoiporus longicolis,* Oliver)
Coleoptera: Curculionidae

a. Pest status: major pest of banana.
b. Also known as the **banana stem weevil and banana pseudostem borer**.
c. Distribution: Widely distributed in banana growing area.
d. Host range: Banana

Mark of Identification:

a. Eggs - laid singly, yellowish white in colour, cut end of pseudo stem.
b. Grub - apodous, yellowish white with dark brown head
c. Pupa - pale yellow in colour, occur in inside the tunneling of pseudostem.
d. Adult - robust, reddish brown and black weevil.

		
Grub	**Pupa**	**Adult**

Nature of Damage:

a. Damage occur above the soil surface.
b. Damaging site is pseudo stem.

c. Exudation of plant sap is the initial symptom.
d. Grub cause damage by tunneling on the pseudo stem.
e. It feed on the tender portion of the pseudo stem.
f. Blackened mass comes out from the bore hole.
g. Tunneled part decomposes and in heavily attacked plants the pseudo-stem is severely weakened and easily breaks in wind.
h. Adult feeds on tissues of leaf sheath from its inner surface and also on decaying tissues.
i. Wilting of the plant occurs.

	
Exudation of Plant sap	**Tunneling in pseudostem**

Life History:

a. Metamorphosis: Complete
b. Site of Oviposition: In small cut of pseudostem, white eggs, hatch in 5-8 days.
c. Larval Stage: Feed on pseudostem, pass through five instar, 15-30 days larval period.
d. Pupation: inside the tunnel of pseudostem, in fibrous cocoon, 6-8 days pupal period.
e. Adult: feed on the tissue of banana plant.

Management:

a. Continuous monitoring in the field of banana, for pest infestation from very beginning.
b. Select healthy rhizomes for planting.
c. Proper disposal off the banana plant after harvesting.
d. Spray chlorpyriphos @ 0.05 per cent for killing attracted adults.
e. For chemical control, inject chlorpyriphos @ 0.05 per cent in the stem with the help of syringe or spraying of chlorpyriphos @ 0.05 % on the tunnel.
f. Remove dried leaves periodically and keep the field clean.
g. Prune the side suckers every month. Do not dump infested materials into manure pit.
h. Use longitudinally split pseudo stem trap at 65/ha.
i. Application of Phorate or Carbofuran @ 5 to 10 gram per plant in the pit prepared for planting.

Syringe application

Banana Aphid

(*Pentalonia nigronervosa,* Coquerel)
Homoptera: Aphididae
Pest status: major pest of banana.
Vector of **Bunchy top Disease of Banana** and **Katte disease of Cardamom**

Distribution: India, Sri lanka, Australia.
Host range: Banana, Cardamom, *Alocasia* sp, *Colocasia* sp, caladium

Mark of Identification:

a. **Nymphs** - are **dark in color.**
b. **Adult** - Adults are 1 to 2 mm long, brownish with antennae as long as body and has **black veined wings** and have cornicles on the abdomen.
c. Both Nymph and Adult mainly found at leaf axil and pseudo stem in colonies.

Nature of Damage:

a. Nymphs and adults both cause damage.
b. Both **congregates under outer leaf base** on pseudo-stems and around crown of the banana plants.
c. Both suck the sap from the leaves causing deformation of plants.
d. The leaves become curled and shriveled and in case of severe infestation young plants are killed.
e. It also secrete honey dew on which black sooty mold grows resulting in decrease of photosynthetic activity and vigor of the plant.
f. Indirectly it cause damage by transmitting the virus responsible for "bunchy top disease" in banana and "Katte disease" in cardamom.

Life History:

a. **Metamorphosis:** Incomplete; parthenogenic and ovo-viviparous.
b. Female give directly birth to nymphs.
c. There are four nymphal instars and become adult within 8-12 days.
d. Adult period is 4 to 19 days.
e. Total life cycle complete within **10 to 26 days**.
f. About 30-40 overlapping generations are completed in a year.

Management:

a. Use **healthy and pest free suckers** to check the pest incidence.
b. Rouge out virus affected plants before spraying.
b. Chemical treatments are generally only effective if accompanied by **careful eradication of infested plants**.
c. Spray monocrotophos 36 SL 1.5 - 2.0 L methyl demeton 25 EC or dimethoate 30 EC 3.0-4.0 L in 1500-2000 L water per ha towards the crown and pseudostem base.
d. Inject pseudostem with monorotophos 36 SL @1 ml in 4 ml of water per tree at 45 days interval from the 3rd month till flowering.
e. Direct the spray towards the **crown and pseudostem base upto ground level**.
f. Encourage activity of Coccinelid predators.

Fruit Rust Thrips

(*Chaetanaphothrips signipennis*)
Thripidae: Thysanoptera

Mark of Identification: Adult - Yellowish white with fringed white wings. Each forewing has two dark area.

Nature of Damage:

a. Damage cause to the fruits.
b. Nymph and Adult cause damage by rasping type mouth type.
c. It cause lacerate the tissue of the fruits and suck the cell sap from it.
d. Due to this rusty reddish discoloration observed on the fingers.
e. Rusty and corky symptoms observed over fruit.

Life History

a. Metamorphosis: Incomplete
b. Oviposition: In plant tissue under leaf sheath, hatch in 2-5 days.
c. Larval Stage: larvae hatch after week and whitish in colour and in later look like adult but without wing.
d. Pupation: in soil, white pupa. 7-10 days pupal period.
e. Adult: emerge from pupa.

Management:

a. Destroy all volunteer plants and **old neglected plantations**.
b. Use **healthy and pest free suckers** for planting.
c. Hot water treatment prior to planting.
d. Bunch covers (which cover the full length of the bunch) protection applied **very early**.
e. Regular monitoring of fruit under the bunch covers is essential to ensure that damage.
f. Soil application **fipronil and bifenthrin**.
g. Field release of **coccinelid** predators like lacewings, ladybird beetles.

Lace Wing Bug

(*Stephanitis typicus)*
Hemiptera: Tingidae
Pest status: minor pest of banana.
Distribution: India, SE Asia, Japan and Korea
Host range: Banana, Ginger, Turmeric, Cardamom.

Mark of Identification:

a. Nymph: are yellow and black in color found on the underside of leaves.
b. Adult: small, dull-coloured or white bugs with transparent shiny lace-like reticulate wings.

Nature of Damage:

a. Damage cause to the Leaves by both Nymph and Adult.
b. Feed under surface of the leaves by sucking the cell sap.
c. Due to this yellowing of the leaves observed.

Management:

a. Remove the infested plant parts.
b. Spray systemic insecticides like Dimethoate or Methyl-o-demeton.

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Hydroponic Fodder Production

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Akshay P. Chawke[1], Pranjali B. Meshram[1], Abasaheb K. Parade[1], Pallavi Dattatray Mali[1]
[1]Ph.D. Scholar, Department of Animal Husbandry and Dairy Science, Mahatma Phule Krishi Vidyapeeth Rahuri, Dist. Ahmednagar-413722.

Introduction

Production of the natural diet for livestock, Green Fodder, to meet the current demand has become a greatest challenge among livestock farmers. Fodder production cannot easily be increased due mainly to ever increasing human pressure on land for production of cereal grains, oil seeds and pulses. India statistically utilizes only 4.9% of gross cropped land for cultivating green fodders and facing a deficit of 35.6% green fodder, 26% of dry fodder and 41% of concentrate feed ingredients (Rachel Jemimah *et al.* 2015). They are the natural diet for animals which improves the fat percentage of milk through rumen digestion and production of volatile fatty acids (VFAs). Further, the green leaves are enriched with beta-carotene that helps in vitamin-A synthesis and plays greater impact on animal reproduction.

It is a science of growing plants in nutrient broth under controlled environment conditions without soil. It can be efficiently used to take pressure off the land to grow green feed for the livestock. This green source claims an increment of 8-13% in milk production and to be the best alternative technology for dairy animals with low-cost materials in places where conventional green fodder production is limited (Prafulla et al. 2015).

Rationale for Scarcity of Green Fodder

1. Rapid urbanization caused decrease of land available for grazing and fodder cultivation.
2. Fragmentation of land reduces land holdings.
3. The farmer prefers to cultivate commercial and food crops over green fodder.

Principles of Hydroponic Technology

Hydroponic system minimizes water wastage since it is applied directly to the roots and is often recycled and used several times. The research findings concluded that hydroponic system equates to only 2-5% of water used in traditional fodder production system (Al- Karaki and Al-Momani 2011, Naik 2014). It has been reported that only 1.5 - 2 liter of water is enough for 1 kg hydroponic fodder production compared to 73, 85, and 160 liters of water to produce 1 kg green fodder of barley, alfalfa, and Rhodes grass under conventional field conditions respectively (Rachel Jemimah *et al.* 2015, Yvonne Kamanga 2016). This is especially important in those areas suffering from chronic water shortages or where the infrastructure for irrigation does not exist.

Reasons for Hydroponic Fodder Production

1. Conservation of water
2. Precise use of Space
3. Reduces growth time

4. Fodder yield.

Methodology of Hydroponic Fodder Production

Seed storage, preparation and washing: In the hydroponic fodder production system, the seed cost contributes 85-90% of the total cost of production (Naik et al. 2014, Rachel Jemimah et al. 2015). It comprises procuring clean, sound, intact, untreated, viable seeds/grains of high quality (Sneath and McIntosh 2003, Naik et al. 2015). Seeds are dried directly under sun light one day prior to seed washing. Seeds are washed thoroughly for 5 minutes with tap water till all dirt and poor-quality seeds are removed. The seeds of various fodders are soaked in stimulant solution (0.1-1.5% sodium hypochlorite or 1-2% hydrogen peroxide solution for a period of 20, 12, 10, 6 and 15 hours for maize, jowar, barley, wheat and bajra respectively (Rachel Jemimah et al. 2015).

Seed cleaning: The seeds should be cleaned in 0.1-1.5% bleach solution (sodium hypochlorite) or 1- 2% hydrogen peroxide solution for 30-60 minutes (Rachel Jemimah et al. 2015, Starova Jeton 2016). The cleaning solution is drained off and seeds are then washed in tap water.

Seed soaking: The seeds are soaked in fresh aerated water for different periods: 4 h (Naik et al. 2014), 8 h (Starova Jeton 2016), 12-16 h or overnight 24 h) depending on the hardness of the seed coat. Temperature of the water or solution used for soaking also affects the germination rate. The optimum temperature at soaking is 23ºC.

Germination of seed: After soaking, the seeds are spread at up to one cm depth in plastic or light weight metallic trays with holes to facilitate drainage of the waste water/nutrient solution, which can be collected in a tank and recycled. The seed rate (quantity of seeds loaded per unit surface area) which varies with the type of seeds also affects the yield of the fodder. The recommended seeding rate for production of hydroponic barley, wheat or sorghum fodder is 4-6 kg/ m2 (Al- Karaki andAlMomani 2011, Starova Jeton 2016) and for maize 6.4-7.6 kg/m2 (Naik and Singh 2013, Naik 2014, Naik et al. 2017).

Loading seeds in trays and racking: A specially constructed frame made of GI pipes or angle bars is erected to hold plastic trays measuring 18” x 32.5” x 2” in which 1-1.25 kg of seed can be placed to produce about 5.5-7.5 kg of green fodder. Other standard size of trays such as 41” x 41” x 7”, 53” x 53” x 7”, 29”x 53” x 7” are also available in the market. The seed trays are clean, washed with cleaning solution & are free from any dust / dirt etc. After germination of seeds, trays are transferred and put them in the sprout section (lower section where the height between two rows is around 5 inches). Finally, trays should be distributed evenly on both sides of the alley.

Shifting trays and harvesting: The germinated seeds are irrigated with fresh tap water or nutrient enriched solution (Table 4). The trays should never be exposed to direct sunlight, strong wind and heavy rain. During the growing period, the seeds are kept moist by drip or spray irrigation but are not saturated. Shift trays to the next level daily so that it moves one step ahead in the growth cycle. Take the last tray out from every row and put it back on the front side of the same row. If left side tray shows more growth, rotate the tray to the right and vice-versa. On 9th day, the fodder mat is harvested from the tray and feeds to the livestock. The trays are washed with cleaning solution before reuse it for the next cycle.

Nutrient Solution for Hydroponic Production

A nutrient solution for hydroponic systems is an aqueous solution containing mainly inorganic ions which play vital physiological role to complete plant life cycle. Currently, 17 elements i.e. carbon, hydrogen, oxygen, nitrogen, phosphorus, copper, potassium, calcium, magnesium, sulphur, zinc, manganese, molybdenum, boron, chlorine and iron, nickel are considered essential for most plants (Salisbury and Ross 1992). Other elements i.e. sodium, silicon, vanadium, selenium, cobalt, aluminum and iodine are also considered beneficial as they stimulate the growth or can compensate the toxic effects of other elements or may replace essential nutrients in a less specific role. The nutrient composition determines essential pH, electrical conductivity and osmotic potential of the solution.

Environment controlled Hydroponic Fodder Production Low-Cost Hydroponic Fodder Production.

Environmental Factors for Hydroponic System

1. Temperature (19 to 22°c).
2. Humidity (average 60%).
3. Light intensity (2000 lux).
4. Length (12-16 h).
5. Aeration for 3 minutes at every 2 h interval should be maintained.

Precautions Techniques for Hydroponic

1. Seed treated with pesticides and fungicides should not be used for cultivation.
2. The water should be replaced at every 3 days to reduce microbial contamination.
3. In order to reduce contamination and fungal growth cleanliness, washing and cleaning should be performed as prescribed. Fungicides should best be avoided as any residue may adversely affect health of animals.
4. White maize seed better as compared to yellow maize for hydroponic fodder production.
5. The seeds should be procured from certified organization and to be used for cultivation.
6. The green shed net is important for aeration and lighting to prevent yellowing of the leave because green shade net allows sufficient light and maintain favourable temperature and humidity for optimum photosynthesis which results better yield of hydroponic fodder.

Table 1. Plant analysis report of hydroponic fodder (maize) on dry matter basis (Ramteke et al. 2019):

Nutrient	Composition
Moisture	89%
Calcium	0.167%
Magnesium	0.24%
Potassium	2.22%
Manganese	53mg/Kg
Zinc	56mg/Kg
Nitrogen	4.6%
Protein	29.87%
Sodium	0.11%
Copper	28mg/Kg
Iron	235mg/Kg
Phosphorous	0.91%

Conclusion

One of the agro-technology which could be developed locally with low-cost materials and is more nutritious, palatable and digestible fodder for livestock is hydroponics. In developed countries, where there is no dearth of quality feed and fodder, the technology is less competitive than traditional fodder production on per kg dry matter basis. It stands a smart alternative technology against scarcity of land and impeding climate changes in different agro- climatic regions in India. Now a day's several countries are practicing it for their sustainable livestock production. Because of greater palatability and digestibility, hydroponic fodders become more lucrative and useful over conventional feeding of cereal grains and concentrate mixture. High initial investment on fully automated commercial hydroponic systems and high labour and energy costs in maintaining the desired environment in the system added substantially to the net cost of hydroponic fodder production. Conversely, low-cost hydroponic systems have been developed by utilizing locally available infrastructure where there is an acute shortage of fodder and water, transportation and fuel costs are high and seasonal variations of fodder prices are extreme. Under such situations the cost structure is often shifted in favour of hydroponic fodder production, and it becomes the best alternative for sustainable livestock production.

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The Black Soldier Fly - An Approach for Waste Management and Alternate Protein Source

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Rani Kumar Sajane[1], Manjunath Madhukar Mopagar[2]
[1]Ph.D Scholar, Department of Entomology, University of Agricultural Sciences, Bengaluru, 560065.
[2]Ph.D Scholar, Department of Agronomy, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shimoga, 577204.

Introduction

The plant-based protein-rich ingredients for increasing poultry industry are competing with human foods at both availability and pricing. Both factors lead to the need for alternative feed ingredients that are cheap, good quality animal protein sources and do not require extensive land and would be available. Further, solid waste management is considered one of the most serious environmental issues as the severity of this challenge is increasing due to rapid urbanization and population growth. Environmental concerns associated with this overwhelming level of waste, include contamination of water, air, and soil. Organic wastes are commonly treated using landfilling, composting, or incineration. However, there are several drawbacks linked with landfill disposal, such as the occupation of valuable space taken up by wastes, the spread of pathogenic organisms, the production of undesirable odours as well as contribution to emission of greenhouse gases. Furthermore, these conventionally used solid waste management methods require large periods of time before the wastes are fully decomposed.

An approach to use insects is well known for playing a vital role in solving issues linked with high volumes of organic waste distributed throughout the world. One of the promising approaches is the utilisation of Black Soldier Fly (BSF) (*Hermetia illucens*) to transform any kind of organic waste biomass into protein-rich larvae which act as alternate substitute to meet the demand of reliable protein for a global population. BSF larvae greedily prey on organic waste, like rotting plants or animal organs, animal, or human manure, food waste, slaughterhouse waste, distiller grains, sludge, etc. The BSF larvae because of their easy production system, rapid growth, and efficient conversion to organic waste can provide good quality feed stuffs containing high quantity of protein (37-63%) and have a better content of amino acids. Additionally, they also contain lipids (15-49%), calcium (8%), phosphorus (2%), sodium (0.1-0.3%) and magnesium (1%) which is isolated and can be used for the production of biodiesel, while the remaining defatted meal can be used as feed for fish, poultry, and pig industry. The use of larvae and prepupae of BSF in place of major protein rich ingredients augments the growth rate in broilers and enhances laying performance and egg quality in layer birds. This source also bears the upper hand in the fattening and optimum growth of the pork industry. Pertinent to this fact, bio-waste conversion by larvae has become a novel approach in past decades. The promising opportunities of using the harvested larvae of BSF as a source of protein for livestock feed, thus, providing a valuable alternative to conventional feed.

The Life Cycle of Black Soldier Fly

The BSF belong to the dipteran family Stratiomyidae, subfamily Hermetiinae. In recent decades, this fly has been encountered in nature worldwide in the tropical and sub-tropical areas between the latitudes of 40 °S and 45 °N. The BSF is considered as "crown jewel" of the fast-growing insect culture industry (Salam *et al.*, 2022).

The BSF consists of 5 stages *i.e.,* egg, larvae, pupae, pre-pupae, and adult. The female fly lays between 200 and 700 eggs once in its lifetime on crevices or surfaces of decaying waste biomass. The larval period lasts for 18 to 36 days which depends on the food substrates provided to the larvae and non-feeding (prepupal) stage lasts around 7 days. The two most important factors, low temperature and food scarcity can delay the period of the larval stage. Only larvae can feed in its entire life cycle and during this time of larval development that enough fat reserves and protein are stored that allow the growth of BSF.

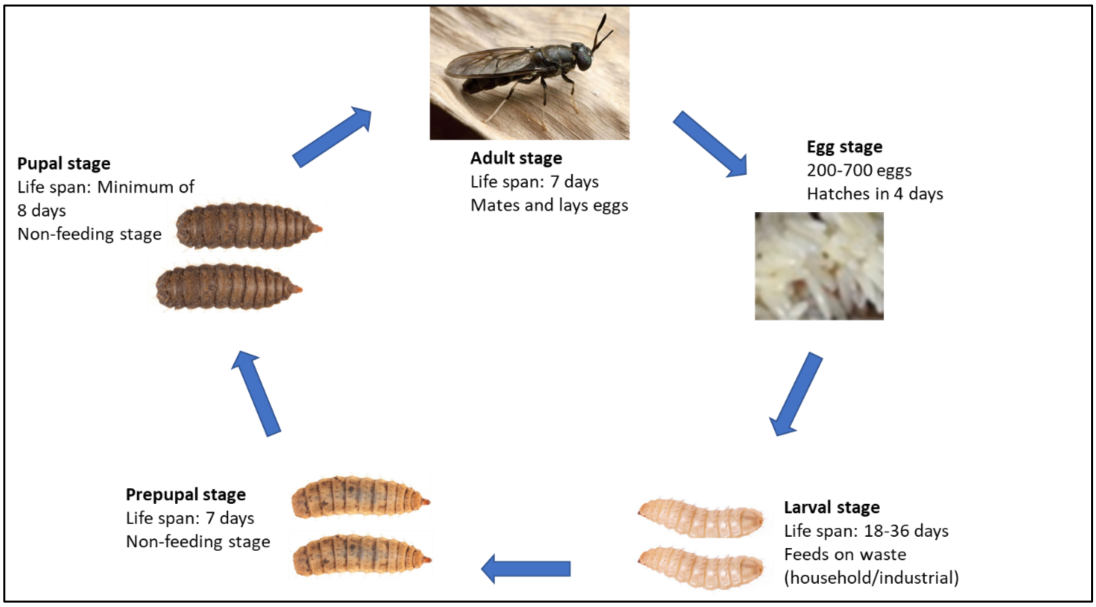

Figure 2. Life cycle of Black soldier fly (*Hermetia illucens*)

The pupation is initiated when the pre-pupa finds a suitable location and the climatic conditions remain warm, dry, and shaded. The fly lives for about one week during this short life, it mates and lay eggs. The flies prefer to copulate in the morning light and after that, they search for an ideal location to lay their eggs. Adults can survive for about 8-10 days on fat reserves gathered during the larval stage with water or live typically 47-73 days when provided with water and sugar as food source in its habitat or nectar in the wild (Shit, 2021). Interestingly, only a source of water or a humid surface is required to stay hydrated and an abundant amount of natural light with temperature (25-32 °C) is important to end their life cycle.

Several Key Attributes which make BSF Technology an Attractive Treatment for Biowaste

1. Solid waste is converted into larvae and residue. The larvae consist of ±35% protein of high quality and ±30% crude fat which is used as feed resource for poultry and fish farmers.
2. Feeding of larvae on waste has been shown to inactivate disease transmitting bacteria, as a result disease transmission between animals and between animals and humans is reduced.
3. Cost for waste transport and space requirements for landfills can be reduced, if treatment is applied at the source of biowaste generation which in turn reduces open dumping of waste.
4. The residue which contains nutrients and organic matter can be used in agriculture to reduce soil depletion.
5. As a business perspective, high waste-to-biomass conversion rate of up to 25% on a wet-weight can be achieved.
6. There is no need of skilled labour and sophisticated technology to operate such a facility.

Process of Bio-Waste Processing

The technology for bio-waste processing includes five main steps:

1. BSF rearing unit: This ensures that a reliable and consistent number of small larvae are always available to inoculate the daily amount of biowaste that is received for processing at the treatment facility. A certain number of larvae hatchlings are, however, kept in the rearing unit to ensure a stable breeding population.

2. Waste receiving and pre-processing unit: The waste received at the facility must be feasible for feeding to the larvae. The first step involves control of the waste biomass to ensure that it contains no hazardous materials and no inorganic substances. Further steps involve a reduction of particle size, dewatering if it waste has too high moisture and a blending of different organic waste types to create a suitable balanced diet and moisture (70-80%) for the larvae.

3. BSF waste treatment unit: This is where the larvae from the rearing unit is fed with biowaste in containers called "larveros". Here, the young larvae feed on the biowaste, grow into large larvae and thus, process and reduce the waste.

4. Product harvesting unit: Shortly before turning into prepupae, the larvae are harvested from the larveros. The waste residue itself is also a product of value.

5. Post-treatment unit (larvae refining and residue processing): Both products, larvae, and residue, can be further processed if required by the local market demand (product refining). Typically, the first step will be to kill the larvae. Other steps of larvae refinement can be to freeze or dry the larvae, or to separate larvae oil from larvae protein. A typical step for residue refinement is composting or feeding the residue into a biogas digester for fuel production.

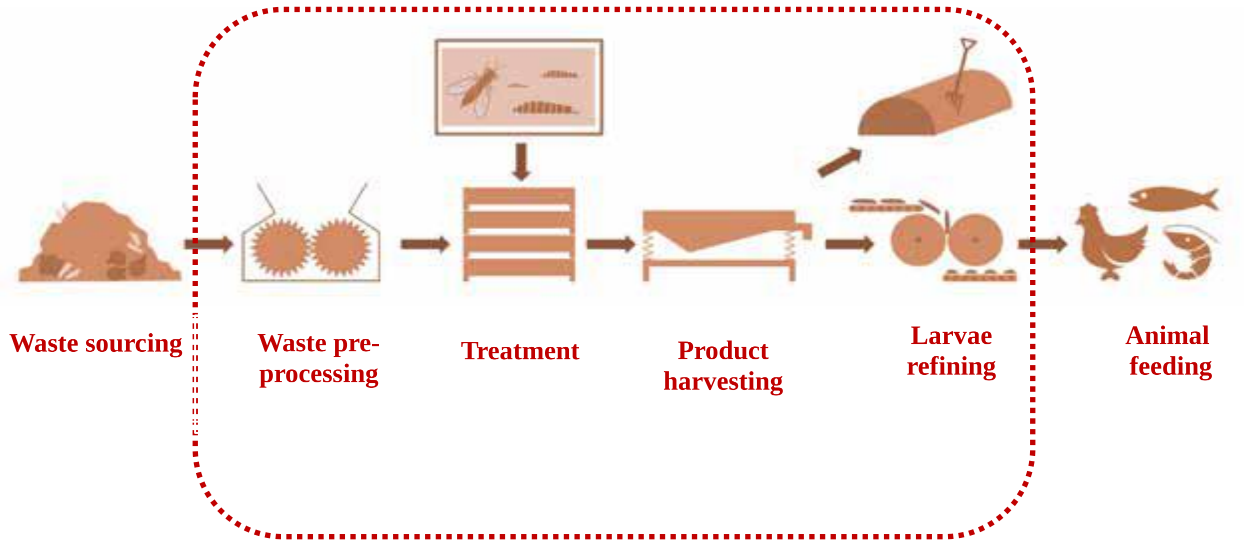

Figure 2. The different units of BSF treatment system (Dortmans *et al.*, 2017)

BSF Larvae as Alternate Protein Source

BSF larvae and pre-pupae could be raised on agricultural by-products and household organic waste and satisfactorily used as poultry feed, offering a potentially sustainable way to recycle untapped resources of waste. It can be used as animal feed either in processed form (as dried larvae or extracted oil/protein meal) or as live larvae. Protein extracted from the larvae and pupae proved as good as soybean or meat meal in the common feed composition. The quality of animal feed is determined by the amino acid composition of proteins and in larvae of BSF essential amino acids which are required for the diet of livestock are found. The content of amino acids in larvae varies depending on the substrate. The amino acid content in the larvae is relatively higher than other sources of common protein used in animal feed.

Since, BSF larvae do not absorb pesticides or mycotoxins have been suggested as alternative sources of protein to corn and soybean meals and hence, as potential ingredients for chicken feed. The use of defatted BSF meal in hens was shown to increase the egg shell thickness and strength. The complete substitution of soybean meal with BSF larvae meal was shown to alter the caecal microbiota in laying hens as the exoskeleton (chitin) modulates gut microbiota and short-chain fatty acids (SCFA) production. Defatted BSF larvae meal is considered as an excellent source of apparent metabolizable energy and digestible amino acid for broilers which potentially result in better efficiency of nutrient digestion. BSF larvae meal can successfully replace a fish meal as a sustainable protein-rich ingredient in growing pig diet as reflected in the growth performance and feed conversion ratio (Siddiqui *et al.*, 2022).

Conclusion

The bioconversion process using BSF in organic waste treatment has become a leading innovation as it has high rate of production with low cost and shorter production period. The natural habitat of the BSF in the wild is to utilize residual organic matter as a rearing substrate which is the main reason that this species is chosen for mass production, due to the ability to consume multiple waste types to achieve excellent product performance in artificial environments. The rearing systems applied for BSF can be adjusted to the condition and demand required. In addition, the ability of BSF larvae to convert waste into useful end products (like BSF meal, BSF biodiesel, chitin, etc.) while also requiring minimal transport and maintenance costs are the most benefits associated with the BSF technology.

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Role of Pulses to Improve Fertility Status of Soil

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Pallavi Bharti[1], Pankaj Kumar Ray[2]
[1]Research Scholar, Birsa Agricultural University, Ranchi, Jharkhand.
[2]Subject Matter Specialist, Krishi Vigyan Kendra, Saharsa, Bihar.

The nutrient Supplying capacity of many soils declined steadily as a result of continuous and intensive cultivation practices. Additionally, due to intensive agriculture, some macro and micronutrients in the soils became deficient. Indian soils are cultivated with negative nutrient balance of 12- 14 mt year-1 and this negative balance will continue to exist even after exploring full potential of fertilizer industry. The productivity and health of the soil are extremely difficult to maintain in this circumstance. Due to increasing population pressure and rising demand for food, forage, shelter, energy, and other needs, land degradation has escalated during the previous two centuries. This, in turn, led to reduce fertility of soil, increase soil contamination, soil acidification and sodification, soil sealing, soil nutrient imbalance, loss of soil organic carbon, soil compaction, waterlogging and loss of soil biodiversity (FAO and ITPS, 2015). Pulses are used to some extent to increase soil health and fertility levels. By biologically fixing nitrogen, mobilising nutrients like phosphorous, increasing the amount of organic matter through root biomass and leaf fall, enhancing microbial biomass, and preventing soil erosion by covering it and encouraging the formation of soil aggregates through their deep root systems and can improve degraded soils (Ganeshamurthy, 2009; Venkateswarlu *et al.,* 2007).

Due to their ability to fix atmospheric nitrogen (N) and their contribution of organic matter to soils, pulses increase soil fertility and decrease the requirement for commercial nitrogen fertilizers. They could conserve up to 120 kg of nitrogen ha-1 when grown in rotation with grain crops. Pulses increase soil biodiversity by supporting a large number of diversified populations of soil organisms. The most important plant nutrient is nitrogen, yet its lack in soils is causing crop yields to decline globally. Fortunately, pulses can biologically fix up to 120 kg of nitrogen ha-1 from the atmosphere.

Pulse Crops in Indian Context

India can be proud that it produces the most pulse crops (grain pulses) worldwide. The majority of pulses cultivated in the country are a variety of legumes, including chickpeas (48%), pigeonpea (15%), mung beans (7%), black gram (7%), lentils (5%) and field peas (5%). Madhya Pradesh (29.36%), Maharashtra (16.16%), Uttar Pradesh (12.97%), Andhra Pradesh (9.75%), Karnataka (7.63%), and Rajasthan (6%) are the largest pulse producing states in the nation (Kumar and Yadav, 2018). Pulses are mostly grown in upland soil in India, where there is a nitrogen shortage but a surplus of phosphorus and other micronutrients.

Pulses as the Builder of Soil Fertility

They support unique soil microorganisms that allow for the biological fixation of nitrogen, a natural process that saves $10 billion in artificial fertilizers every year. They also promote cleaner water filtering and soil carbon sequestration. Pulses are widely acknowledged and regarded as “soil building” crops because of their positive effects on the biological, chemical, and physical characteristics of the soil. The following are ways that extensive pulse cultivation might benefit soil health:

Nitrogen fixation and phosphorus release: Legumes and certain Rhizobium bacteria (rhizobia) interact during the nitrogen (N) fixation process to make nitrogen from the soil air surrounding the roots available for uptake by the plant. The type of crop, crop health, the amount of nitrogen already presents in the soil, and other environmental factors all affect how much nitrogen is fixed. Pulses can fix up to 50% to 80% of their entire nitrogen needs under optimum circumstances, with the remaining nitrogen coming from fertilizers or soil sources. About 21 million tonnes of nitrogen are produced annually by pulses (Stagnari *et al.*, 2017). Pigeonpea fixes and cowpea releases the most nitrogen into the soil of all pulse crops (Gill *et al.,* 2009). They also help in efficient use of soil phosphorus by breaking down the insoluble phosphates in soil.

Effect on soil organic carbon (SOC): The majority of crop residues are far higher in carbon than nitrogen, which is essential for soil bacteria's greater activity. Pulses' nitrogen contribution makes crop residues in the soil break down more quickly and turn into organic carbon that helps build soil. By promoting the fast breakdown of Crich crop residues in the soil and their conversion into soil organic carbon, pulses increase C-sequestration in the soil (SOC).

Recycling of nutrients: Pulse crops can recycle crop nutrients found deep in the soil profile because of their extensive root systems. Organic acids, which are frequently released by pulse crops that improve the soil profile, mobilized inaccessible soil nutrients like Ca, K, P, and Fe. Low C/N ratios cause pulse residues to break down fast, improving soil fertility when enough nutrients are added (Stagnari *et al.*, 2017). The pulses in rotation not only increase nutrition availability but also are responsible for biological nitrogen fixation.

As a crop residue: Besides supplementing the fertilizer, incorporation of residues of pulse crops are important for improvement of the soil properties and thereby increasing productivity and fertilizer use efficiency. Low C/N ratios in pulse crop residues cause them to breakdown more quickly and contribute to improved soil fertility by supplying a good quantity of readily available nutrients. Adding chopped wastes and then irrigating them improves microbial breakdown and mineralization.

Conclusion

The cultivation practices of nitrogen-fixing pulses for restoring soil fertility are the basis of most organic systems. Pulses can help the soil and its associated beneficial microorganisms in a variety of ways, increasing the mineralization process and, as a result, the availability of nutrients to crops.

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Registration of Plant Variety

Article ID: 40714

Dr. A. Thanga Hemavathy[1]

[1]Associate Professor (PBG), ADAC & RI, Trichy.

With the signing of TRIP's agreement of the World trade organization (WTO) India has agreed to provide protection of plant varieties. The government of India therefore enacted "The protection of Plant Varieties and Farmers' Rights act (PPV&FR).in 2001 and the regulations for implementing the act were formulated in 2003. The Indian law, which has been trailed ad a progressive legislation, has few notable features. The legislation gives concurrent attention to the rights of farmers, breeders and researchers and protection of public interest. The Ministry of Agriculture, Government of India identified a nodal agency to implement the registration of varieties through an authority. Under the act any variation within a species that satisfies the definition of varieties and fulfill the criteria of DUS as specified in the PPV&FR act, 2001 can be registered.

Registration of a plant variety gives protection only in India and confers upon the rights holder, its successor, agent, or licensee the exclusive right to produce, sell, market, distribute, import, or export the variety. Rights holders can apply for the registration of a new variety either directly or through their agents. The Office of the Registrar, Protection of Plant Varieties and Farmers' Rights Authority is the appropriate office for filing of the application in India. The different steps that are involved in the registration process in India are as follows:

The Applicant has to file the prescribed form with the requisite fee in the Office of the Registrar. The Applicant can make an application to the Registrar for registration of any variety of such genera and species as specified under sub-section (2) of Section 29 or which is an extant variety or which is a farmer's variety. An agent can complete and sign the application form, provided that the Applicant has issued a signed Power of Attorney appointing them as the agent. The application has to be in respect to a variety and state the denomination assigned to such variety by the Applicant. It has to be accompanied by an affidavit sworn by the Applicant that such variety does not contain any gene or gene sequence involving terminator technology and also a statement containing brief description of the variety bringing out its characteristics of novelty, distinctiveness, uniformity and stability. The application should also contain a complete passport data of the parental lines from which the variety has been derived along with the geographical location in India from where the genetic material has been taken and all such information relating to the contribution, if any, of any farmer, village community, institution, or organization in breeding, evolving, or developing the variety. It should also contain a declaration that the genetic material or parental material acquired for breeding, evolving, or developing the variety has been lawfully acquired.

The Applicant must, along with the application for registration under this Act, also make available to the Registrar such quality of seeds of a variety for registration of which such application is made so that the Registrar can conduct tests to evaluate whether seeds of such variety along with parental material conform to the standards as may be specified by regulations. The Applicant should also deposit the requisite fees for conducting such tests.

Review by the Registrar

After the application has been filed, the Registrar will accept the application absolutely or subject to certain conditions or limitations, after reviewing the application and making such inquiry as he deems fit. If the Registrar is not satisfied with the particulars as mentioned in the application, he can either direct the Applicant to amend the application or in the alternative reject the application.

Publication and Opposition

After the Registrar accepts the application either absolutely or subject to any conditions, it will be advertised in the prescribed manner along with its photographs or drawings. Within three months of the publication of this application, any person may give notice of his opposing the application to the Registrar in the prescribed format. Any person can oppose the application on the following grounds.

1. The person opposing the application is entitled to the breeder's right as against the Applicant;
2. The variety is not registerable under the Protection of Plant Varieties & Farmers' Rights Act,2001Act;
3. The registration of this variety will not be in public interest; or
4. The variety may have adverse effect on the environment.

After following the prescribed procedure of serving the Notice of Opposition to the Applicant, perusing the evidence as filed by both the parties and hearing both the parties, the Registrar will either allow or reject the opposition.

Registration

When an application for registration of a variety (other than an essentially derived variety) has been accepted and not opposed or opposed but the opposition has been rejected, the Registrar will issue a certificate of registration to the Applicant. A person aggrieved by the decision of the Protection of Plant Varieties and Farmers' Rights Authority or the Registrar can file an appeal before the Plant Varieties Protection Appellate Tribunal.

The Distinctiveness Uniformity and Stability test guidelines have been finalized for 12 notified crop species: Black gram, Bread wheat, Chickpea, Field pea, Green gram, Kidney bean, Lentil, Maize, Pearl millet, Pigeon pea, Rice and Sorghum and the registration for these crops has started.

Term of Registration

The certificate of registration issued by the Registrar is valid for eighteen years from the date of registration of the variety in the case of vine and trees, fifteen years from the date of notification of that variety (under Section 5 of the Seeds Act, 1966) by the Central Government in the case of extant varieties and for a period of fifteen years from the date of registration of the variety in other cases. However, the certificate of registration is valid for a period of nine years in the case of trees and vines and six years in the case of other crops. The Registrar may review and renew this registration for the remaining term on payment of the prescribed fee.

Researcher's Right

Though the rights holder has the exclusive right to the use of a registered variety, no provision of the Act precludes the researcher's right to the use of any variety for conducting experiments or research or the use of a variety as an initial source for creating other varieties. However, the researcher will have to seek the rights holder's authorization where the repeated use of such variety as a parental line is necessary for commercial production of a newly developed variety.

Revocation

There are certain circumstances in which the protection that has been granted to a rights holder can be revoked. These circumstances in which the same can be done are enumerated below:

1. The grant of the certificate of registration has been based on incorrect information furnished by the rights holder;
2. The registered proprietor is not eligible for protection;
3. The rights holder has not provided the Registrar with such information and documents as are required under the Act;
4. The rights holder has not provided the Registrar with an alternative denomination, which could be used in case the denomination provided by the rights holder is not available;
5. The rights holder has not provided the necessary seeds or propagation material to the person to whom a compulsory license has been issued;
6. The rights holder has not complied with the provisions of the Actor the accompanying Rules; The rights holder has not complied with the directions of the Protection of Plant Varieties and Farmers' Rights Authority; or
7. The grant of the certificate is not in public interest.

The Registrar also has the authority to either cancel or rectify the registration on an application made by an aggrieved person.

Compulsory License

Any person, after expiry of three years from the date of registration, can apply to the Protection of Plant Varieties and Farmers' Rights Authority for a compulsory license for undertaking production, distribution, and sale of the seed or other propagating material on the grounds that the reasonable requirements of the public for seeds or other propagating material of the variety have not been satisfied or that the seed or other propagating material of the variety is not available to the public at a reasonable price. This application should contain a statement of the nature of the compulsory license Applicant's interest and the facts upon which the application is based. The Protection of Plant Varieties and Farmers' Rights Authority in consultation with the Central Government and after hearing both the parties may pass an order for the registered proprietor to grant the license on such terms and conditions as the Protection of Plant Varieties and Farmers' Rights Authority deems fit. Furthermore, the Protection of Plant Varieties and Farmers' Rights Authority will determine the duration of the compulsory license on a case-to-case basis but in no event will the duration of the license exceed the total remaining period of the protection.

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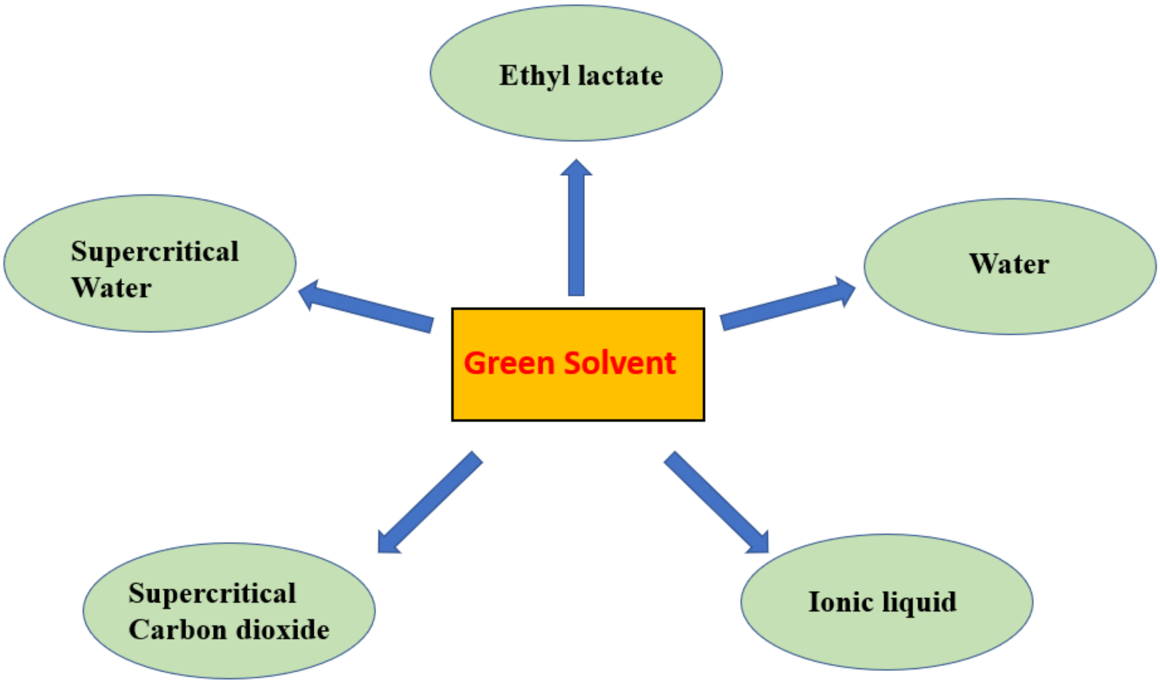
Green Solvents

Article ID: 40715

Anuradha Beniwal[1], Sushila Singh[1], Jyoti Rani1, Monika Moond[1], Pinki Matoria[1], and Seema Sangwan[1], Vikas Dhanda[2]
[1]Department of Chemistry, CCS Haryana Agricultural University, Hisar, Haryana, India.
[2]Department of Psychology, Om Sterling Global University, Hisar, Haryana, India.

Introduction

Biosolvents, commonly referred to as green solvents, are solvents with positive environmental effects that are produced via the processing of agricultural products (Hernáiz *et al.*, 2010). As a more eco-friendly substitute for petrochemical solvents, green solvents were created.



1. Ethyl lactate: One of the environmentally friendly solvents is made from corn. It is a frequently used solvent in the paint and varnish sector and offers a number of alluring benefits, including being 100 percent biodegradable, simple to use, non-corrosive, non-carcinogenic, and non-ozone. Ethyl lactate is a suitable solvent because of its low vapour pressure, high boiling point, robust resolution and low surface tension. The workplace is made safer by using ethyl lactate in place of xylene, toluene, and acetone. (Wan *et al.*, 2012).

2. Ionic liquids: Ionic liquids are electrolytes that are fully made up of ions and have melting points below the boiling points of water. Ionic liquids are also known as, designer solvents, ionic fluids, molten salts, and neoteric solvents. A large organic cation that contains nitrogen and a smaller inorganic anion makes up an ionic liquid. A salt with a low melting point is produced as a result of the asymmetry's reduction of the crystalline structure's lattice energy. Simple liquid salts (monoanionic and cation) can be combined with various inorganic salts to create multi-component ionic liquids. It is possible to create an ionic liquid with the needed properties for a specific application by choosing the appropriate anions and cations (Yang & Pan, 2005).

3. Supercritical Water (scH_2O): Supercritical water has fundamentally different physical characteristics from ambient liquid water. Higher acidity, lower density, and lower polarity of supercritical water (scH_2O) considerably increase the spectrum of chemistry that can be performed in the water. Terephthalic acid is created using ScH_2O as a solvent. Conventional terephthalic acid synthesis uses acetic acid as the solvent, air, a manganese/cobalt catalyst combination and p-xylene at 190 °C and 20 atm pressure (Shanab *et al*., 2013).

4. Supercritical carbon dioxide ($scCO_2$): When the temperature and pressure of carbon dioxide are kept at or above their critical points, it is said to be in supercritical condition. It is nonflammable, nontoxic, and affordable. One of the processes occurring in $scCO_2$ is the heterogeneous catalytic hydrogenation of isophorene using supported palladium as catalyst and hydrogen gas.

$ScCO_2$ is used to spin-coat photoresists in the microelectronics sector instead of traditional organic solvents. $ScCO_2$ has a lower surface tension than conventional solvents, making it more successful at cleaning fine details on flat-panel displays and integrated circuits (Alvarez *et al*., 2011).

5. Water: One of the best answers to the issue of solvent toxicity and disposal is the use of water as a solvent for chemical processes. Water serves as the foundation for the chemistry in natural systems (biochemical processes). Future synthetic chemistry that uses water as a solvent has a lot of potential for more affordable and risk-free chemical manufacturing (Erdmenger *et al*., 2010).

Conclusion

We must concentrate on every element of the chemical reaction if we want to achieve nearly 100% "greenness" of chemical processes. sMost business responses to environmental regulation and protection up to this point have been of the situational type, such as limiting human exposure to harmful materials. However, an intrinsic method (such as using the molecular design) can be not only more dependable but also less expensive.

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Eco Friendly Natural Farming Practices for Sustainable Fruit Production

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Soniya Rishi[1], Naveen Kumar Meena[2]
[1]Ph.D Scholar Department of Extension Education, [2]Ph.D Scholar Department of Genetics and Plant Breeding,
Rajasthan College of Agriculture (MPUAT) Udaipur.

Introduction

Eco friendly natural farming is a form of agriculture that depends on various techniques such as vermicomposting, crop rotation, green manure, Animal Husbandry, Bio fertilizers and biological pest control. Organic farming is the form of doing crop/plant cultivation by using organic manures which are eco-friendly manures that supports the life of soil and other useful organisms in the soil. Organic farming is an adapted practice in developing countries, where farmers use animals for tilling the land and manures prepared by dung and other waste material of animals. Organic farming supports the crop yield and quality of production. Most of the developed countries use synthetic chemicals to protect from insects, pests and other plant diseases. The use of synthetic chemicals may give high yield for some time and protects the plants but the continuous use of chemical in farming, useful organisms in soil become inactive and the insects or pests and other diseases gain resistance to the chemicals and later the chemicals may not show its effect on the pests, insects and other harmful organisms to the crops. Organic farming system in some developing countries like India is not new and is being followed from ancient days. Bio fertilizers are prepared with beneficial microbes which release nutrients to soil and support the crop growth and product yield without any environmental pollution

Various Means of Eco-Friendly Natural Farming

With the rising awareness about the environmental harm caused by large-scale agriculture, eco-friendly farming has become a priority. The solution which can offset damages such as forest clearings, destruction of habitats, the negative impact of pesticides and intense carbon outputs is sustainable farming. Both policymakers and environmentalists are actively promoting eco-friendly and sustainable farming solutions to overcome these damages. Here are the top 5 sustainable farming practices which guarantee a green and environmentally friendly growth of vegetables and plants.

1. Permaculture: Permaculture is a food production system which mimics how vegetables and plants grow in natural ecosystems. It applies natural principles which combine intention, smart farming and design to reduce waste of resources and increase production efficiency. The design techniques in permaculture include growing grains and vegetables without tillage, each plant undertaking various purposes, herb and plant spirals, hügelkultur beds and developing swales to hold water.

2. Aquaponics & Hydroponics: Aquaponics and hydroponics are innovative farming methods which involve soilless plant and vegetable growth, feeding the plants with nutrients which are carried by the water. Hydroponics systems involve using mineral solutions to feed the plants' roots directly in a passive medium such as perlite or gravel. However, aquaponics farming systems combine aquaculture and hydroponics elements. Water which contains nutrients resulted from the mineralization of fish waste feeds the roots of plants and vegetables which can grow in various mediums. The water is purified by the plants and returns to the hydroponics section of the system.

3. Using Renewable Energy Resources: Sustainable farming involves the use of alternative energy sources such as hydropower, solar power or wind farms which are eco-friendly. Solar panels can be used to run pumping and heating systems. Also, hydroelectric power sourced from river water can be used for various farming machinery.

Farmers can compare energy consumption rates by using an online energy compare site to identify the best suitable power sources.

4. Crop Rotation & Polycultures: Farmers can decrease the chances of plant and vegetable diseases through crop diversification on a surface of land and through crop rotation techniques. The practices can also reduce the number of pesticides and chemical fertilizers required.

5. Trees Can Increase Crop Yields: Agroforestry is a farming method which involves growing shrubs and trees among other plants and vegetables. It combines forestry and agricultural practices to guarantee a sustainable and highly productive approach to land use. The system mimics forest ecosystems found in nature, and it's designed to comprise multiple layers of food forests. It includes perennial plants such as fruit trees, perennial herbs, mushrooms, and other vegetables on the ground level and underground root vegetables. Compared to traditional farming systems, agroforestry can double crop yields and significantly decreases the need for chemical fertilizers or pesticides.

Methods of Organic Farming

Organic farming involves various techniques which are eco-friendly and by practicing it the fertility of soil is conserved for long time. There are various methods in organic farming some of them are Crop rotation, use of green manures, biological pest control and composting, these also provide employment to agriculture labours.

Employment to agriculture labours: In present day machinery are replacing manpower and making them unemployed but with organic farming it provides employment because many techniques are used, from preparation of manure to cop harvesting.

Crop rotation: It is a technique of growing different crops in same area according to the seasons and it is practiced avoiding agriculture pests, and to maintain soil fertility.

Green manures: Green manures are the plant leaves and waste material of plant which cover the soil and stuffed into soil and become as nutrient to the soil and increase the soil fertility.

Vermicomposting: It is a process of composting using different worms like white worms, earth worms and red wrigglers for preparation of compost with mix of kitchen waste and other vegetable waste. This is rich in nutrients and used as fertilizers in the agriculture fields.

Biological pest control: Living organisms are used to protect plants from peats without synthetic chemicals.

Advantages of Organic Farming

Organic farming is an important form of doing agriculture which has many benefits to ecosystem such as:

Nutrition: Organic food is rich in nutrients and it is free from harmful chemicals, it also increases the nutrients in the soil so the grown crop is healthier to consume.

Free from chemicals: In organic farming chemicals are not used to control pests and other harmful plant diseases, which causes cancer and other diseases to the consumers. But organic farming is free of toxic chemicals.

Quality food: The organic food is having quality with nutrients, and it tastes better than the food grown by using synthetic chemicals and quality of food is determined by its taste. Brix analysis is used to measure the quality of vegetables and fruits.

Long Time Store: Organic food has the capability of longer time storage due to its metabolic and structural integrity in their cellular structure than the other crops grown by using synthetic chemicals.

Low input cost: Expenditure on agriculture is low with organic farming because it needs animals to till the land, manures which are easily available and they can prepare their own, and the bio fertilizers are prepared with low cost.

Limitations

Apart from advantages organic farming is demerits they are:

1. Organic farming is a time taking process in getting the result, which makes the farmers to neglect this kind of farming.
2. It requires more labour force and should have regular observation compared to conventional farming.

3. Organic farming is a skill-based work and farmers should be trained time to time according to the seasons and the condition of the crops.
4. Low productivity is the major problem in organic farming compared to conventional farming, but in conventional form of agriculture the fertility of soil is decreasing time to time with excess use of chemicals.

However, it has some disadvantages it is a useful form of doing agriculture, which benefits the ecosystem and the consumers. The soil gains the nutrients and maintains the soil fertility for longer time and useful for agriculture.

Smart Nitrogen Management in Agricultural Crop

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Sheetal Singh[1], Dr. Anoop Kumar Devedee[2]
[1]Student (M.Sc Agronomy), Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur, Uttar Pradesh.
[2]Assistant Professor (Agronomy), Institute of Agricultural and Natural Science, Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur, Uttar Pradesh.

Abstract
Fertilizer nitrogen is the single 'Most Variable Production Input' which farmers used in crop production; Nitrogen plays a critical role in plant growth. It is present in various parts of a plant and affects many physiological functions. It makes up a large part of the chlorophyll found in plants, which is used to make sugars that feed the plant. In addition, nitrogen impacts plant growth regulation as well as the development of proteins present in a crop's grains, fruits, and seeds. Most of the Indian soils are low in N and the requirement of N by crops throughout its growing period, therefore, N should be applied in such a way that plant gets it throughout its life period .it becomes absolutely necessary to apply N fertilizers to every soil and crops. For this reason, the total requirement of N is more compared to fertilizers of other groups. With the continued increase in fertilizer costs, nitrogen use efficiency becoming increasingly important for production as well as environmental quality. Hence, it helps in saving the N fertilizers and ultimately low cost of cultivation and less environmental impact.

Keywords: Nitrogen, NUE, Smart N management practices, new approaches of N application.

Introduction
Nitrogen plays a critical role in plant growth. It is present in various parts of a plant and affects many physiological functions. For example, nitrogen is a significant component of the amino acids in the proteins and enzymes that help roots absorb nutrients and water. It makes up a large part of the chlorophyll found in plants, which is used to make sugars that feed the plant. In addition, nitrogen impacts plant growth regulation as well as the development of proteins present in a crop's grains, fruits, and seeds. Balance of course, is essential. Too little nitrogen and crops may not thrive, and too much nitrogen can harm plants and the environment. Because certain conditions are necessary to facilitate the roots' ability to uptake nutrients that are present in the soil, crops can experience nutrient deficiencies when growing conditions are poor. Very acidic or alkaline conditions, extreme temperatures, drought, and heavy rains can all influence nutrient availability in soil and its subsequent absorption by crops. This means that at times nutrients may be present in the soil, however not available to the plants. Forms of soil nitrogen: The total N content of soil ranges from 0.02% in subsoil to more than 2.5% in peats. The N present in soil can classified as organic and inorganic forms, Organic nitrogen compounds: The organic forms of soil nitrogen occur as consolidated amino acids or protein, free amino acid, amino sugars and other complex compounds. Inorganic nitrogen compounds: These includes ammonium (NH^{4+}), nitrite (NO^{2-}), nitrate (NO^{3-}), nitrous oxides (N_2O), nitric oxides (NO) and elemental nitrogen (N).

Nitrogen Cycle
Nitrogen is important to all life. Nitrogen is changing its chemical form continually and moving from plants through animals, soil, water and the atmosphere. This movement and transformation of nitrogen in the environment is known as the ―Nitrogen Cycle". Critical processes in the nitrogen cycle affecting manure handling and plant growth include the following: Mineralization, Nitrification, Immobilization, Volatilization, Denitrification, and Leaching.

Nitrogen Management
Nitrogen management is one in which the time and amount of nitrogen application is prescribed prior to planting of nitrogen application is prescribed prior to planting accounting for soil nitrogen supply, crop nitrogen demand, fertilizer nitrogen efficiency and fertilizer and crop prices.

Smart N Management Comprise

1. Precision nitrogen management
2. Real-time nitrogen management
3. Site-specific nitrogen management
4. Need to be based nitrogen application
5. Split or slow-release N management Smart nitrogen management means.

Farmers generally apply nitrogen fertilizer in several splits, but the number of splits, amount of nitrogen applied per split, and the time of applications are not as per requirement as well not as per recommended. When N loss is minimized, the nitrogen available to growing plants is maximized. Smart use resources for years to come.

Nitrogen Management Practices

Selection of Nitrogen fertilizers:

1. Rate of application
2. Method of application
3. Split application
4. Real-Time N management or Site-Specific Nitrogen Management or Precision N management
5. Use of slow-release N fertilizers (SRF) - Nitrification inhibitors (NI's)
6. Urease inhibitors - Balanced fertilization - Site Specific Nutrient Management (SSNM)
7. Integrated nitrogen management
8. New approaches viz. GPS, GIS & VRA (Variable Rate Application.

Conclusion

By the in-judicious use of chemical fertilizers, farmers are happy of getting maximum yield in agriculture in the beginning. But slowly, the chemical fertilizers especially nitrogenous fertilizers started showing their ill-effect such as leaching out, volatilization and lower NUE. Hence, fertilizer prices increasing day by day this leads more cost of cultivation and impact on environment. As fertilizer N has generally been managed blanket recommendations consisting of two or three split applications of the total amount of N, improvement in NUE could not be achieved beyond a limit.

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Scope and Importance of Underutilized and Unexploited Vegetable Crops

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Rachna Kumari[1], Jaya Kiran[1]
[1]Department of Horticulture (Vegetable & Floriculture), Bihar Agricultural University, Sabour Bhagalpur, 813210.

Vegetables are the major component of balanced diet and also the main component in achieving global nutritional security by providing nutrients, vitamins and minerals as it is also known as protective food. In India, vegetables alone contribute major percentage of total horticultural production. However, this remarkable production was contributed by only few major vegetables. Some of the vegetables are not cultivated on a large scale these are termed as underutilized vegetable. Underutilised vegetables species as "those species with underexploited potential for contributing to food security, health (nutritional/medicinal), income generation, and environmental services" (Jaenicke and Hoeschle, 2006). The vegetables, which are neither grown commercially on large scale nor traded widely, may be termed as underutilized or underexploited vegetable crops. These crops are cultivated, traded and consumed locally. The popularity of these vegetables varies from crop to crop and locality to locality, but it can be enhanced to a greater extent through publicity. It is easy to grow these vegetables due to its hardy nature, producing a crop even under adverse soil and climatic conditions. Most of them are very rich sources of vitamins, minerals, and other nutrients such as carbohydrates, proteins and fats and also possess different medicinal properties. Local people are aware of their nutritional and medicinal properties. They are cheap and readily available sources of nutritive food. Important vegetable crops that grown as underexploited are Asparagus, Amaranthus, Basella, Moringa, Ivy gourd, Globe artichoke, Kale, spine gourd, ivy gourd, sweet gourd, pointed gourd, long melon, snap melon, pickling melons, sword bean, jack bean, lima bean e.t.c.

Scope of Underexploited Vegetables

1. Wastelands can be used for growing low input crops in order to diversify the present-day agriculture, which is so inevitable in view of the increasing population pressure and fast depletion of natural resources as well as the growing and changing human needs in the region.
2. They form a cheap source of proteins, minerals like potassium, calcium, sodium, as well as vitamins like Vitamin C, Vitamin A, and other phyto-nutrients like lycopene, beta-carotene, etc.
3. Underutilized vegetables are particularly more important for medicinal properties and famous for the retentive value in Ayurvedic medicine.
4. It can be used for enhancement of the average productivity of horticulture in the national level by utilization of land that is not suitable for traditional crops and thus can provide food and nutritional security considering the continuously increasing population of our country.
5. With proper publicity of these vegetables their growth can be popularised in our country.

Potential Role of Unexploited Vegetables

1. Food security and better nutrition: Many underutilized vegetables are nutritionally rich and are adapted to low-input agriculture. Their enhanced use can maintain the nutrition in our body. For example, such underutilized vegetables contain more amount of vitamin C and pro-vitamin A than widely available commercial species and varieties. Focusing attention on underutilized vegetables is an effective way to help maintain a diverse and healthy diet and to overcome the micronutrient deficiencies and other dietary deficiencies particularly among the rural poor and the more vulnerable social groups in developing countries.

2. Increased income for rural poor: The growing demand from consumers in developed and developing countries for different and diverse in foods is creating new market niches for unexploited vegetables. These market opportunities can generate additional income for poor farmers in less-favoured environments where these crops have comparative advantages over major commercial crops.

3. Ecosystem stability: Due to continuos change in climate and the degradation of land and water resources have led to a growing interest in crops and species that can grow in to difficult environments such as desert margins, those with poor soil or degraded vegetation, or subject to drought.

Health Benefits of Some Unexploited Vegetables

1. Celery- Celery contains dietary fibre, it has some sugar but no starch. Good source of Vitamin A, C, B, B2, Ca, Mg, P, Si, K, Na. Tones heart muscle and lowers blood pressure. Coumarin in celery is useful for toning heart muscle and blood vessels. Leaves diuretic and appetite stimulant. The use of celery seed in pills for relieving pain was described by Aulus Cornelius Celsus around AD 30. Celery is used in weight-loss diets, where it provides low-calorie dietary fibre bulk.

2. Parsley- Parsley is a source of Flavonoid, and Antioxidants (especially luteolin), apigenin, folic acid, vitamin K, vitamin C, and vitamin A. Excessive consumption of parsley should be avoided by pregnant women. It is safe in normal food quantities, but large amounts may have uterotonic effects.

3. Parsnip- The consumption of parsnips has potential health benefits it contains anti-oxidants such as falcarinol, falcarindiol, panaxydiol and methyl-falcarindiol which have anti-cancer, anti-inflammatory and anti-fungal properties. The high fibre content of parsnips may help prevent constipation and reduce blood cholesterol levels.

4. Lettuce- Rich source of Vit. A, Ca, Fe.

5. Globe Artichoke- The globe artichoke has become important as a medicinal herb in recent years following the discovery of cynarin. This bitter-tasting compound, which is found in the leaves, improves liver and gall bladder function, stimulates the secretion of digestive juices, especially bile, and lowers blood cholesterol levels. They are used internally in the treatment of chronic liver and gall bladder diseases, jaundice, hepatitis, arteriosclerosis and the early stages of late-onset diabetes.

6. Asparagus- Asparagus is used by physicians and herbal specialist to treat diseases in the such as, Moistens dry tissues of the reproductive organs, kidneys, stomach and lungs. It also acts as an antioxidant and antiallergic, it is used by the Pharmaceutical Companies for making drugs, which is used in case of disease like cough dehydration, diarrhoea, dysentery, fevers (chronic), hematemesis, herpes, hyperacidity, stomach ulcers and also helpful in cases of infertility.

Conclusion

Underutilized vegetables are full with nutrients along with ability to stand against adverse climatic conditions. It is key weapon to fight with malnutrition. These vegetables can help to all concerns – growers and consumers, so there is need to publicity of these vegetables.

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Role of Organic Farming / Eco-Friendly Agriculture for Sustainable Development in Rain-Fed and Dry-Land Areas

Article ID: 40720

Prachi Patel[1], Amit Tomar[1], A. K. Mishra[1], S. P. Singh[1], R. P. Singh[1], H. H. Khan[1]
[1]ICAR-Krishi Vigyan Kendra, Gajraula, Amroha, (Directorate of Extension), SVPUA&T, Meerut, U.P., India.

Introduction

Organic farming is a farming technique that sustains, enhances and maintains the quality of the ecosystem. Consequently, organic farming does not have harmful and deteriorating effects on the ecosystem. The traditional farming system focuses heavily on output. With the advent of green and the golden revolution, India was self-reliant and a major producer of various crops. It also introduced output oriented technologies like HYV seeds, new fertilizers, pesticides etc. Of course, this changed the course of Indian agricultural history and pulled our country out from famines. But eventually, such techniques led to the deterioration of the various ecosystems. Thus, organic farming, bringing eco-friendly techniques, began to change this aspect of traditional farming. A simple search for sustainable development brings us to the most basic definition that is an economic development conducted without depletion of natural resources. In essence, organic farming is intimately connected to every principle of sustainable development. Organic farming is helping us to restore the ecological balance. Organic farming is a production system where all kinds of agricultural products are produced organically, including grains, meat, dairy, eggs, fibers such as cotton, flowers and processed food products. Organic farming avoids or largely excludes the use of synthetic fertilizers, pesticides, growth regulators and livestock feed additives.

Need & Scope of Organic Farming

1. The most important aspect of organic farming is its ecological balance maintaining abilities,
2. Compared to traditional farming techniques (introduced with the green and the golden revolution), Organic farming tends to be cheaper and can be easily grown locally. For example inputs like HYV seeds are costlier as compared to organic substitutes,
3. The organic outputs are healthier and possess more nutritional value as compared to the traditionally grown counterparts,
4. Organic techniques are more labour intensive. Hence it is favourable in countries with the abundance of labour like India,
5. Export of organic outputs fetches high prices because of their health benefits. Effectively, they result in an inflow of profitable foreign currency reserves,
6. Chemical fertilizers and pesticides accumulation degrade the soil fertility and lad to soil erosion. On the contrary, organic techniques refrain from the use of fertilizers hence are eco-friendly,
7. Increase in awareness and health consciousness,
8. Global consumers are increasingly looking for organic food, which is considered safe, and hazard free,
9. The global prices of organic food are more lucrative and remunerative,
10. The potential of organic farming is signified by the fact that the farm sector has abundant organic nutrient resources like livestock, water, crop residue, aquatic weeds, forest litter, urban, rural solid wastes and agro industries, bio-products,
11. India offers tremendous scope for organic farming as it has local market potential for organic products.

Principles (International Federation of Organic Agriculture Movements-IFOAM, 1972)

1. To produce food of high quality in sufficient quantity.
2. To interact in a constructive and life-enhancing way with natural systems and cycles.
3. To consider the wider social and ecological impact of the organic production and processing systems.

4. To encourage and enhance biological cycles within the farming system, involving micro- organisms, soil flora and fauna, plants and animals.
5. To maintain and increase the long-term fertility of soils.
6. To maintain the genetic diversity of the production system and its surroundings, including the protection of wild life habitats.
7. To promote the healthy use and proper care of water, water resources and all life therein.
8. To use, as far as possible, renewable resources in locally organized production systems.
9. To give all livestock conditions of life with due consideration for the basic aspects of their innate behaviour.
10. To minimize all forms of pollution.
11. To allow everyone involved in organic production and processing a quality of life which meets their basic needs and allows an adequate return and satisfaction from their work, including a safe working environment.
12. To progress towards an entire production, processing, and distribution chain which is both socially just and ecologically responsible.

Advantages of Organic Farming

1. Nutrition - Improved soil health makes food dramatically superior in mineral content.
2. Poison-free- Free of contamination with health harming chemicals like pesticides, fungicides and herbicides.
3. Food tastes better
4. Food keeps longer - can be stored longer.
5. Disease and pest resistance - because of healthy plants.
6. Weed competitiveness - Healthier crops able to compete.
7. Lower input costs - No costly chemicals used; nutrients are created in-situ (in the farm).
8. Drought resistance.
9. More profitable - Due to greater food value of organic produce consumers are willing to pay premium prices.

Disadvantages of Organic Farming

1. Productivity-Low productivity is often reported as the quantum nutrient used comparatively lower,
2. Labour intensive - Cultivation requires more labour especially for weed control,
3. Skill-requires considerable skill to farm organically Ex. Choice of alternatives for control of pests,
4. Lack of convenience in management compared to easier management like fertilizer application in conventional methods.

Synonyms of Organic Farming

Eco-farming or biological farming or Bio-dynamic farming or Macrobiotic agriculture.

Eco-Farming

1. Farming in relation to ecosystem.
2. It has the potential for introducing mutually reinforcing ecological approaches to food production.
3. It aims at the maintenance of soil chemically, biologically and physically the way nature would do it left alone.
4. Soil would then take proper care of plants growing on it.
5. Feed the soil, not the plant is the watchword and slogan of ecological farming.

Dry-land Agriculture for Sustainable Development

Indian agriculture is predominantly a rain-fed agriculture under which both dry-farming and dry-land agriculture are included. Out of the 143 million ha of total cultivated area in the country, 101 million ha (i.e. nearly 70%) area are rain-fed. In dry-land areas, variation in amount and distribution of rainfall influence the crop production as well as socio-economic conditions of farmers. The dry-land areas of the country contribute about 42% of the total food grain production. Most of the coarse grains like sorghum, pearl millet, finger millet and other millets are grown in dry-lands only. The attention has been paid in the country towards the development of dry-land farming. Efforts were made to improve crop yields in research projects at Manjari, Solapur, Bijapur, Raichur and Rohtak. An all-India coordinated research project for Dry-land Agriculture was launched by ICAR in 1970 in collaboration with Government of Canada and later Central Research Institute for Dry-land Agriculture (CRIDA) was established at Hyderabad.

Characteristics of Dry-Land Agriculture

Dry land areas may be characterized by the following features:
1. Uncertain, it will distribute and limited annual rainfall
2. Occurrence of extensive climatic hazards like drought, flood etc.
3. Undulating soil surface
4. Occurrence of extensive and large holdings
5. Practice of extensive agriculture, i.e., prevalence of mono cropping etc.
6. Relatively large size of fields
7. Similarity in types of crops raised by almost all the farmers of a particular region
8. Very low crop yield
9. Poor economy of the farmers.

Dry-Land Agriculture

It is the profitable production of useful crops, without irrigation, on lands (arid and semi-arid) that receive annual rainfall of less than 750mm.

Rainf-ed Agriculture

It is the profitable production of useful crops, without irrigation, on lands (humid & sub humid regions) that receive annual rainfall of more than 750mm.

Table-1: Difference between Rain-fed and Irrigated farming:

S.No.	Rain-fed farming	Irrigated farming
1	In a certain part of the year crop is grown where rainfall received	Throughout the year depending upon the water availability
2	Crops/crop varieties having drought tolerance or less water requirement are used	According to the need, crops or their varieties are selected
3	Duration of crops depends on the rainfall duration/ growing period most of the times short duration (LGP)	Depending upon the need
4	Mixed cropping is beneficial	Generally pure cropping is done
5	Due to limitation of moisture one or two crops in a year is possible	More than two crops in a year are grown, subject to availability of water
6	The field is ploughed to deep to increase infiltration of rains	No need for deep ploughing to conserve soil moisture
7	Land is prepared immediately after rainfall	Land is prepared according to optimum time of sowing
8	Risk of crop failure is expected due to insufficient soil moisture or drought	No risk of crop failure

Improved Dry-Land Technologies

Following are the various improved techniques and practices recommended for achieving the objective of increased and stable crop production in dry-land areas.

1. Crop planning: Crop varieties for dry-land areas should be of short duration through resistant tolerant and high yielding which can be harvested within rainfall periods and have sufficient residual moisture in soil profile for post-monsoon cropping.

2. Planning for weather: Variation in yields and output of the dry-land agriculture is due to the observation in weather conditions especially rainfall. An aberrant weather can be categorized in three types viz.,

a. Delayed onset of monsoon.

b. Long gaps or breaks in rainfall and
c. Early cessation of rains towards the end of monsoon season.

Farmers should Make Some Changes in Normal Cropping Schedule for Getting Some Production in Place of Total Crop Failure

1. Crop substitution: Traditional crops/varieties which are inefficient utilizer of soil moisture, less responsive to production input and potentially low producers should be substituted by more efficient ones.

2. Cropping systems: Increasing the cropping intensities by using the practice of intercropping and multiple cropping is the way of more efficient utilization of resources. The cropping intensity would depend on the length of growing season, which in turn depends on rainfall pattern and the soil moisture storage capacity of the oil.

3. Fertilizer use: The availability of nutrients is limited in dry-lands due to the limiting soil moisture. Therefore, application of the fertilizers should be done in furrows below the seed. The use of fertilizers is not only helpful in providing nutrients to crop but also, helpful in efficient use of soil moisture. A proper mixture of organic and inorganic fertilizers improves moisture holding capacity of soil and increase during tolerance.

4. Rain water management: Efficient rain water management can increase agricultural production from dry-land areas. Application of compost and farm yard manure and raising legumes add the organic matter to the soil and increase the water holding capacity. The water, which is not retained by the soil, flows out as surface runoff. This excess runoff water can be harvested in storing dugout ponds and recycled to donar areas in the server stress during rainy season or for raising crops during winter.

5. Watershed management: Watershed management is a approach to optimize the use of land, water and vegetation in a area and thus, to provide solution drought, moderate floods, prevent soil erosion, improve water availability and increase fuel, fodder and agricultural production on a sustained basis.

6. Alternate Land use: All dry-lands are not suitable for crop production. Same lands may be suitable for range/ pasture management and for tree farming and ley farming, dry-land horticulture, agro-forestry systems including alley cropping. All these systems which are alternative to crop production are called as alternate land use systems. This system helps to generate off-season employment mono-cropped dry-land and also, minimizes risk, utilizes off-season rains, prevents degradation of soils and restores balance in the ecosystem. The different alternate land use systems are alley cropping, agri-horticultural systems and silvi-pastoral systems, which utilizes the resources in better way for increased and stabilized production from dry-lands.

Conclusion

While rain-fed regions undoubtedly offer good scope for organic production at least in niche areas and commodities, a number of research, development and policy issues need to be addressed before realizing the potential.

1. Prepare an enlarged list of crops, herbs and livestock products which can be sourced from rain-fed regions considering the international trade in organic food and allied products.
2. Carry out a country wide survey/incentivization of areas in arid, semiarid and dry sub humid regions about the level of chemical input use, productivity in selected commodities which have potential to fetch price premiums in international markets.
3. Identify contiguous blocks of areas with little or no chemical input use and where productivity can be enhanced by using permitted inputs to enable group certification to farmers.
4. To develop protocols for organic production of important commodities through farmers participatory network research. These protocols should be based on the entire cropping system approach and not on individual seasonal crops.
5. To create awareness and capacity building of different stakeholders on different aspects of organic production like cultivation, harvesting, certification and marketing.
6. Develop preferential policy instruments for rain-fed farmers particularly in terms of providing market information, subsidized supply of inputs and group certification.

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Novel Strategy in Nitrification Inhibition - BNI

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Shivashankar K[1], Pooja C A[1], Sourabh Munnoli[1], Kiran Emmiganur[1], Shivanand Goudra[1]
[1]PhD Scholars, Department of Agronomy, University of agricultural sciences, Dharwad.

Introduction

Agriculture is the single largest human activity altering the global N cycle. Organic-N mineralization, nitrification and denitrification are important components of soil-N-cycle. Plants have the ability to utilize various forms of N *viz.,* organic-N, ammonium (NH_4^+)-N and nitrate (NO_3^-)-N. However, NH_4^+ and NO_3^- are the primary N forms utilized by plants. Nitrification and denitrification are components of the N-cycle critical to the removal of N from soil N pool.

In agricultural systems, nitrification is the dominant pathway for N flow. Majority of nitrogen generated in nitrification process is excess, which is way beyond the needs of agricultural production system. This makes N cycle prune to the greater loss of reactive nitrogen to environment, making agricultural system the major source of environmental N pollution. However, in agricultural systems, rapid and uncontrolled nitrification results in inefficient N-use by crops, leading to N-leakage and environmental pollution. Synthetic nitrification inhibitors have been criticized for their difficulties in application, cost, environmental safety and transport in food system.

One alternative that has gained importance in recent days is use of compounds from root exudates which inhibits nitrification naturally, known as biological nitrification inhibitors. The ability of certain plant species to release organic molecules/ compounds from their roots that specifically inhibit the function of nitrifying bacteria in soil, is a phenomenon termed as "biological nitrification inhibition" (BNI) (Subbarao *et al.* 2006). An evaluation of a various tropical forage grasses, cereal and legume crops have indicated a wide range in the BNI-activity. While root exudates have long been postulated to control soil nitrification, only in the past decade have their presence and function been definitively demonstrated in pasture crops *viz., Brachiaria humidicola*, Guinea grass and cereals like sorghum, rice, wheat and *Leymus racemosus*, a wild relative of wheat.

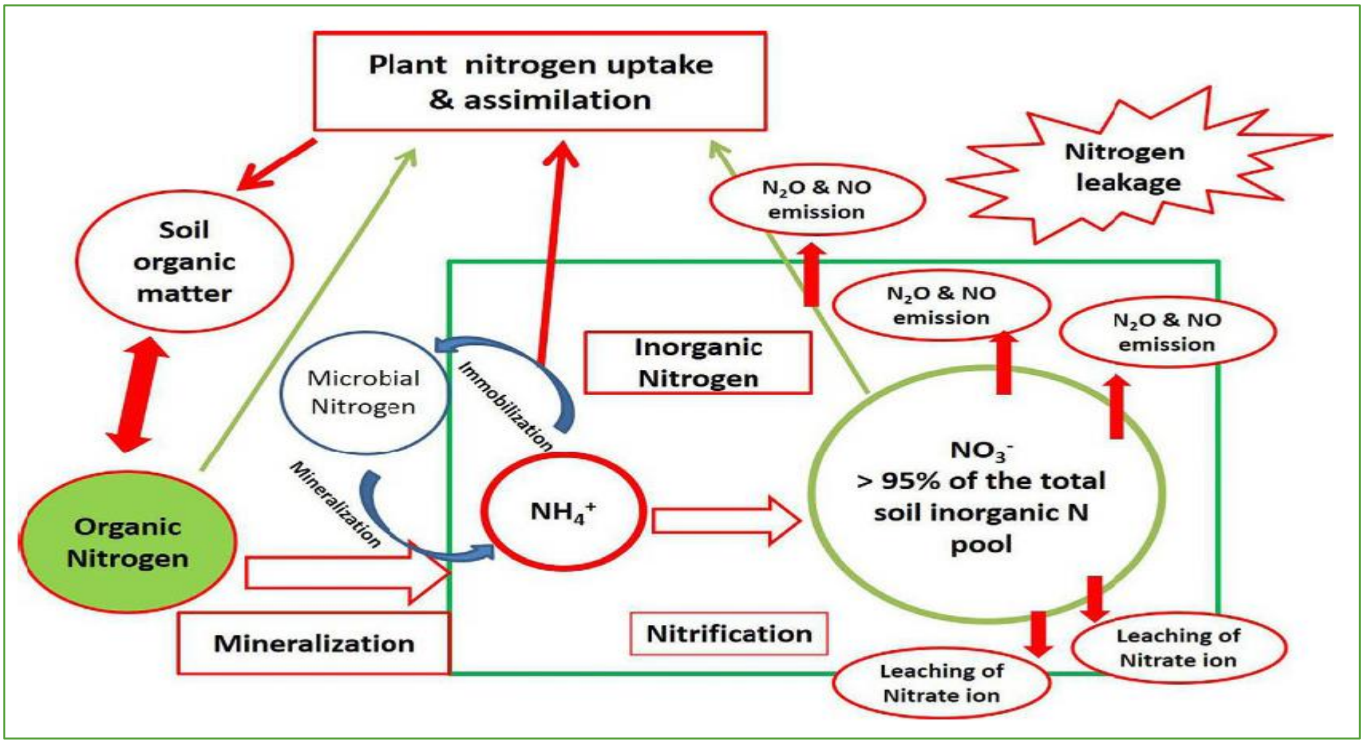

Fig. 1: The nitrogen cycle in a typical agricultural system

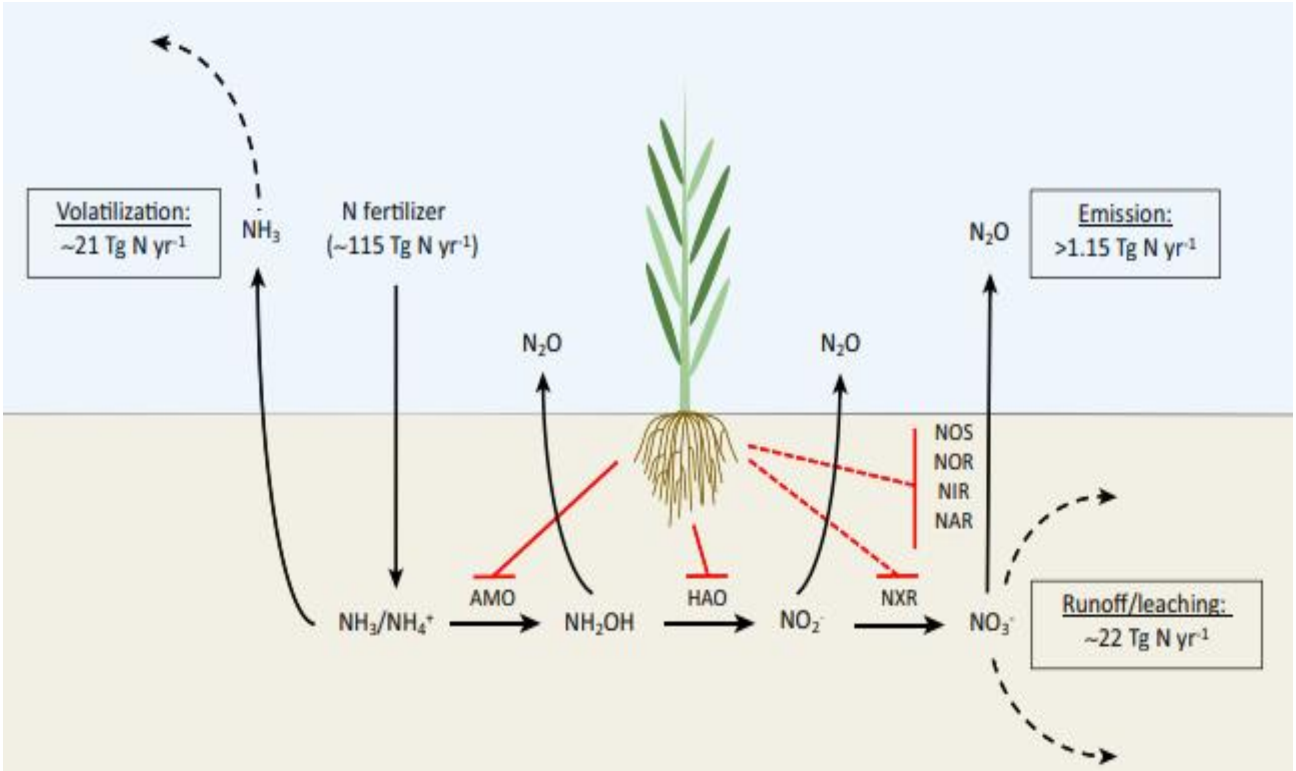

Fig. 2: Root exudates as a means to mitigate agricultural nitrogen losses

Research Studies

Subbarao *et al*. (2009) identified the major Nitrification Inhibitors (NIs) released from roots of B. *humidicola* and named "brachialactone" which inhibits *Nitrosomonas* sp. by blocking ammonia monooxygenase (AMO) and Hydroxylamine Oxidoreductase (HAO) enzymatic functions. They estimated that BNI-activity of 2.6×10^6 to 7.5×10^6 allylthiourea unit (ATU) ha^{-1} day^{-1} could potentially be released from B. *humidicola* roots, which amounts to an inhibitory potential equivalent to the application of 6.2 to 18 kg of nitrapyrin ha^{-1} $year^{-1}$. Nitrous oxide emission was also suppressed by >90 per cent in field plots planted to B. *humidicola* as compared to the emission from plots of soybean, which lack BNI capacity.

Sun *et al*. (2016) identified 7 rice varieties (3 weeks old seedlings) and 15 rice varieties (6 weeks old seedlings) of the 19 selected rice varieties that have the ability to inhibit nitrification and 1,9-decanediol was extracted as a new type of BNI from rice root exudates. ZJ25 and WYJ7 varieties, at 6 week of age, were the most effective varieties with regard to nitrification inhibition among *indica* and *japonica* varieties, respectively, with both exhibiting >40 per cent inhibition. They compared the BNI potential of 1,9-decanediol with other inhibitors and found that similar inhibitory effect of 1,9-decanediol to that of AM (2-Amino-4-chloro-6-methylpyrimidine) but more effective than DCD.

Villegas *et al*. (2020) studied the biological nitrification inhibition (BNI) activity of 119 germplasm accessions of Guinea grass (*Megathyrsus maximus*). They found that inhibition in nitrification activity ranged from 30 to 70 per cent across the germplasm collection of M. *maximus*. Accessions with low nitrification rates showed a lower abundance of Ammonium Oxidizing Bacteria (AOB) as well as a reduction in N_2O emissions compared to accessions of high nitrification rates. The N_2O emission under high nitrification rate (NR) accessions was 2.5 times more than the low NR.

Otaka *et al*. (2021) isolated two hydrophobic BNI compounds released from maize root exudation (Zeanone and benzoxazinoid 2-hydroxy-4,7-dimethoxy-2*H*-1,4-benzoxazin-3(4*H*)-one (HDMBOA)), together with two BNI compounds inside maize roots (HMBOA and HDMBOA-β-glucoside). They noticed that these four isolated BNI compounds contributed 19 per cent, 20 per cent, 2 per cent and 4 per cent, respectively to the hydrophobic BNI activity in maize. Overall, these compounds contributed 45 per cent of the total BNI activity in maize roots.

Kishii *et al*. (2021) evaluated the impact of BNI function on N_2O emissions and nitrifying populations in root-zone soils of field-grown wheat lines and they noticed 30 per cent reduction in soil nitrate levels, substantial improvement in ammonium levels, 26 per cent decline in net nitrification rate and N_2O emission by 25per cent (by laboratory studies) under BNI-MUNAL as compared to control. They also noticed that BNI-MUNAL suppressed ammonia-oxidizing archaea ranging from 20 to 36 per cent and yielded 10-14 per cent higher than MUNAL control.

Zhang *et al*. (2015) evaluated the effects of chemical and biological nitrification inhibitors on N_2O emissions and the nitrogen use efficiency (NUE), a 2-year field experiment with four treatments regular urea (Urea), urea + dicyandiamide (DCD), urea + nitrapyrin (CP) and urea + biological nitrification inhibitor (BNI) carried out in an intensive vegetable cropping system. The results showed that the CP and BNI treatments reduced the NO_3^- concentration and maintained NH_4^+ in soils. They also noticed that CP and BNI treatments significantly decreased annual N_2O emissions relative to the Urea treatment by 16.5 per cent and 18.1 per cent and improved NUE by 12.6 per cent and 6.7 per cent, respectively.

Karwat *et al*. (2017) investigated the residual effect of BNI by B. *humidicola* pastures on subsequent grain yield of maize. They revealed that grain yields of maize from plots established after the previous B. *humidicola* pasture (Bh) were higher than in the maize field (M) for all respective N and DCD treatments. The agronomic N use efficiency (ANUE) in plots after the previous pasture out performed those in the continuous maize field with ANUE of 85 kg grain/kg N fertilizer and 37 kg grain/kg N fertilizer, respectively when 60 kg N/ha was applied.

Conclusion

1. BNI-activity released from B. *humidicola* roots, amounts to an inhibitory potential equivalent to the application of 6.2 to 18 kg of nitrapyrin ha^{-1} $year^{-1}$.
2. 1,9-decanediol root exudate from rice was successful in inhibiting nitrification by 37-47%. Four BNI compounds isolated from maize contributed 45 per cent of the total BNI activity in maize roots.
3. Introduction of BNI traits from wild relatives of wheat to commercial variety was found to decline net nitrification rate by 26 per cent, N_2O emission by 25 per cent, suppressed ammonia-oxidizing archaea (20-36%) and yielded 10-14per cent higher than MUNAL control (Non-BNI).
4. *S. bicolor* rotation with vegetables increased the annual yield by 19.2 t ha^{-1} yr^{-1} with increasing the NUE by 6.7 per cent and by reducing cumulative N_2O emissions by 18.1per cent.
5. *B. humidicola* rotation with maize increased the yield of subsequent maize crop by increasing the NUE and N uptake by plants.

Future Line of Work

1. Allelopathic effect of these root exudates need to be studied
2. Identification and proper integration of BNI crops into cropping system
3. Longevity/persistence of the BNI compounds under field condition need to be studied
4. Need to study the releasing pattern of BNI compounds under different soil types.

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Seed Production Technology of Foxtail Millet in India

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Amit Tomar[1], A.K. Mishra[1], S. P. Singh[1], Prachi Patel[1], H. H. Khan[1], R. P. Singh[1]
[1]ICAR-Krishi Vigyan Kendra, Gajraula, Amroha, Directorate of Extension, SVPUA&T, Meerut, U.P., India.

Introduction

Foxtail millet (*Setaria italica*) is a well-known small millet variety belonging to the family Gramineae. Foxtail millet is mostly grown mixed with other crops like cotton, castor, pigeon pea, bajra, groundnut and finger millet. It is also grown as a pure crop, particularly in black cotton soils where it is followed by a rabi crop like coriander in favorable seasons or by safflower or horse gram in years of less rainfall. Foxtail or Italian millet may well have unrealized potential and the Chinese have claimed exceptionally high yields sometimes exceeding 11,000 kg/ha. However, in India the yield of rainfed pure crop varies from 400-800 kg of grain and 1000-2000 kg of straw per ha. Generally cooked like rice or made into porridge, it makes a food which is considered to be very nutritious. The grain must be pounded or otherwise husked before cooking to remove the tightly enclosed glume. Research on forage quality shows foxtail is similar in quality to other C4 annual grasses. It is finer-stemmed and easier to cure than pearl millet or forage sorghum.

Origin

Foxtail millet (*Setaria italica*) is also known as Italian or German-Hungarian or Siberian millet. Foxtail millet was considered to be domesticated in the highlands of central China. The main production regions of the world include China, parts of India, Afghanistan, Central Asia, Manchuria, Korea, and Georgia. It is also one of the specialty crops in Japan. In Asia it is mainly grown for human consumption. It was recently introduced in the United States for hay or silage. Because of its short growth cycle, it is a suitable crop for nomads, and it was probably brought to Europe in this way during the Stone Age, as seeds abound in the Lake Dwellings in Europe.

Adaptation

It is cultivated in both tropical and temperate regions. The crop can be grown successfully in areas receiving 750 mm of annual rainfall. Foxtail millet is essentially a grain crop of about 100 days duration suited to conditions of low and moderate rainfall ranging from 500 to 700 mm. It can be grown in higher altitudes (up to 1830 m above MSL) and is an important food grain in the foothills of Himalayas. It is a crop grown almost throughout the year in different parts of the country. Cultivation of foxtail millet in the lower Deccan Plateau including high lands of Andhra Pradesh, Karnataka and Tamil Nadu account for about 90 per cent of the area in the country. In the hilly regions of North India, foxtail millet is sown with other kharif crops and matures in about 2 months, providing food during scarcity periods. In Punjab, Himachal Pradesh and U.P. it is grown from June-July to September-October either as a border or as a mixed crop with several kharif crops.

Botany

Growth and development of foxtail millet is well documented. A progressive shortening of the vegetative period occurs with later plantings, and stem elongation is determined by the length of the vegetative period. Stem elongation was hastened by late sowing and was retarded by early sowing. The transition from vegetative growth into inflorescence takes place very rapidly. In the lower third of the cone of growth, initial humps of secondary axes appear following enlarged growth of the growing point, with the middle and upper parts still undifferentiated. Later, secondary axes differentiate up to the very top into points of growth. The inflorescence of foxtail millet has a main stalk with shortened side branches bearings spikes and bristles. The first flowers of foxtail millet may open when three fourths of the panicle emerge from the sheath, or as many as five days after full emergence. Flowering proceeds from the top of the head downward in each of the panicle branches. A large head may take 8 to 16 days to compete flowering. A single floret may remain open about 30 min, and about 80 min are required for the complete blooming process, which is hastened by high temperatures and low humidity.

Crop Specific Issues

Foxtail millet is grown mainly as a dry land crop in semi-arid regions receiving an annual rainfall of less than 125mm. The time of planting typically ranges from May through July. The crop cycle depends on the cultivar and on growth conditions; it may range from 60 to 120 days with a productivity ranging from 800 to 900 kg/ha of grain and about 2500 kg/ha of straw. If the crop is grown for hay or silage it should be harvested when in bloom, since the protein concentration at that stage peaks around 12 – 14%.

Seed Production

Best season for seed production is June - July and February – March. The pollination should not coincide with rains for quality and effective seed setting.

Table-1: List of recently notified foxtail millet varieties in India:

Variety name	Year of release	State of release	Remarks
SiA 3085	2011	Central	
HMT-100-1	2007	Karnataka	
Co(Te) 7	2005	Tamil Nadu	
Pratap Kangni-1 (SR-51)	2003	Rajasthan	Bold seed
Meera (SR-16)	1999	Rajasthan	Stay green character
Pant Setaria-4 (PS 4)	1998	Central	Wide adaptation and high yield
Gavari (SR-11)	1995	Rajasthan	High seed yield
TNAU-43	1994	Tamil Nadu	
Krishna Devaraya	1993	Andhra Pradesh	High seed yield
Lepakshi (AK-132-1)	1990	Andhra Pradesh	Drought tolerant, high seed yield
K-3	1989	Tamil Nadu	High seed yield
Nischal	1988	UP	High seed yield

Field Standards

Foxtail millet is a self-pollinated crop and should be raised in isolation. The isolation distance maintained between the varieties is 3 metres for both foundation and certified seed production to maintain the varietal purity.

Table-2: Field standards for seed certification in foxtail millet:

Field standards	Foundation seed	Certified seed
Minimum field inspection (number)	3	3
Minimum isolation distance (metres)	3	3
Maximum off-type (%)	0.05	0.10
Maximum objectionable weeds (%)	-	-
Maximum different crop plants (%)	-	-
Maximum objectionable diseases (%)	-	-

Seed Standards

The percentage of minimum physical purity of certified and foundation seeds should be 97% with a minimum of 75% of germination capacity and 12% of moisture content. The presence of inert matter should not exceed 2.0%.

Table-3: Seed standards for seed certification in foxtail millet:

Seed standards	Foundation seed	Certified seed
Minimum physical purity (%)	97	97
Maximum inert matter (%)	2	2
Maximum other distinguishing varieties (number/kg)	-	-
Maximum other crop seed (number/kg)	10	20
Maximum other weed seed (number/kg)	10	20
Maximum objectionable weeds (number/kg)	-	-
Maximum objectionable diseases (percentage by number)	-	-
Minimum germination (%)	75	75
Maximum moisture (%)		
Ordinary container	12	12
Vapour proof container	8	8

Seed Agronomy & Crop Management

Early sowing in the monsoon always produces higher yields than later sowings. The longer duration varieties gave higher fodder yield when sown early.

Land Selection

Foxtail millet needs moderately fertile soil for good yield. The selected land should be free from volunteer plants. The land should not be cultivated with same crop in the previous season. Land should be ploughed 2 - 3 times to get a fine tilth and levelled.

Seed Selection and Sowing

Seeds used for seed production should be of good quality certified seeds from an authentic source. Seeds should be healthy with required germination percentage. Recommended seed rate is 2 kg/acre (5 kg/ha). Selected seeds should be treated with *Azospirillum* @ 125 gms/kg of seeds. Treated seeds should be sown with a spacing of 30 x 10 cm at a depth of 3–4 cm.

Main Field Preparation

The main field should be ploughed for 2 – 3 times to make it a fine tilth and formed into ridges and furrows. During final plough apply compost or farmyard manure @ 5 tonnes/ acre (12.5 tonnes/ ha) and incorporate into the soil. Seeds can be sown in the ridges at a depth 3 - 4 cm with a spacing of 30 × 10 cm.

Nutrient Management

Before final ploughing compost or farmyard manure @ 5 tonnes/acre (12.5 tonnes/ha) should be applied and ploughed into the soil. Instead of this cattle penning can also be practiced. 50 kg neem cake and 500 kg vermicompost per acre (125 kg neem cake and 1250 kg vermicompost per hectare) should be applied as basal manure. For rainfed crop, apply 50 kg/acre (125 kg/ hectare) of pungam cake and 250 kg/acre (600 kg/hectare) of vermicompost as basal manure just before sowing. After first weeding at 20 – 25 days after sowing top dressing should be done using enriched vermicompost (2 kg *Azospirillum*, 2 kg *Phosphobacterium* and 2 litres *Panchagavya* mixed with 250 kg vermicompost and kept covered for a week and then used) @ 250 kg/acre (600 kg/ha). During flower initiation stage 10% tender coconut solution (1 litre tender coconut water + 9 litres of water) should be sprayed. All the above-mentioned inputs should be applied to the rainfed crop only when the soil is wet.

Weed Management

The seed production field should be maintained weed free. Weeding can be done with a tyne harrow when the crop is 30 days old. Allow the weeds to dry for 2 - 3 days after hand weeding.

Irrigation

Kharif season crop does not require any irrigation. It is mostly grown as a rainfed crop. However, if the dry spell prevails for longer period, then 1 - 2 irrigations should be given to boost the yield. Summer crop requires 2 - 5 irrigations depending upon soil type and climatic conditions. During heavy rains the excess water from the field should be drained out.

Roguing

Roguing should be done often to remove the off-types, volunteer plants and diseased plants from the seed production field to avoid the genetic contamination. Roguing should be done up to the flowering stage. Maximum percentage of off- types permitted at the final inspection is 0.05% for foundation and 0.10% for certified seed production.

Field Inspection

A minimum of two inspections should be done between flowering and maturity stages by the Seed Certification Officer. The first inspection is done at the time of flowering to check the isolation and off-types and the second inspection is done during the maturity stage prior to harvest to check the off-types and to estimate the yield.

Harvesting and Processing

Harvest is done once the earheads are physiologically mature. Normally crop is ready for harvest in 80 - 100 days after sowing. Physiologically mature earheads will start to dry. Plants are either harvested intact with earheads or earheads alone. The earheads are dried before threshing. The earheads are threshed by stone roller or trampling under the feet of bullocks. The threshed grains are further cleaned by winnowing.

Drying and Storage

The cleaned seeds should be dried under the sun to attain a safe moisture level of 12%. Care should be taken while drying to avoid mechanical injury to the seeds and contamination. Seeds can be stored upto 13 months under proper storage conditions.

Crop Diseases and Pests Management

Foxtail millet is affected by pests like army worm, cut worm, leaf scrapping beetle and shoot fly and diseases like blast and rust at different growth stages. Sowing early in July minimized the incidence of blast and rust.

Blast, Brown Spot and Rust

If these diseases appear at the early stages of the crop, spray Mancozeb (0. 2%).

Grain Smut
Seed treatment with Carbendazim @ 2 g/ kg seed.

Downy Mildew
Seed treatment with Ridomil MZ @ 2 g/litre. Roguing out and destroying the affected plants.

Army Worms, Cut Worms and Leaf Scraping Beetles
Need based dust application of Malathion 5 % @ 3.2 – 4.0 kg/ha.

Role of Soil Conservation Machinery in Dry Land Mechanization

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B. Suthakar[1], G. Thiyagarajan[1], M. Nagarajan[1], M. Manikandan[2], V. Sivakumar[3]
[1]Agricultural Engineering College & Research Institute, TNAU, Kumulur, Tamil Nadu (621 712), India.
[2]Agricultural Research Station, TNAU, Kovilpatti, Tamil Nadu (628 501), India.
[3]Horticultural College & Research Institute, TNAU, Coimbatore, Tamil Nadu (641 003), India.

Introduction

Dry land agriculture is the practice of crop production entirely with rain - water received during the crop season and on conserved soil moisture in low rainfall areas of arid and semi- arid climates and the crop may face mild to very severe moisture stress during their life cycle. Inrainfed regions, the annual precipitation is lower than the evapo-transpiration demand particularly in arid and dry semi-arid zones. Based on the amount of rainfall received, dryland agriculture can be grouped into three categories, *viz.* Dry Farming (Cultivation of crops in areas where rainfall is less than 750 mm per annum), Dryland Farming (Cultivation of crops in areas receiving rainfall above 750 mm) and Rainfed Farming (Cultivation of crops in regions receiving more than 1,150 mm) (TNAU Agri tech portal). About 68 per cent of the cultivated area in Indian agriculture comes under dryland, which contributes about 44 per cent of the total food production and plays a critical role in India's food security. Coarse cereals (85%), pulses (83%), oilseeds (70%), and cotton (65%) are the predominant rainfed crops grown in India (Roshni., 2016). India has about 108 million hectares of rainfed area which accounted for nearly 75 per cent of the total 143 million hectares of arable land. Out of 108 million hectares of total rainfed area, dry lands constitute about 47 million hectares (Ref. [4].

In Tamil Nadu, cereals *viz*., Jowar, Bajra, ragi and maize, pulses, *viz*., black gram, green gram, red gram, oilseeds, *viz*., ground nut, gingelly, and cotton are largely grown in dry lands. In Tamil Nadu, around 51 lakh hectares are the net cultivated area in which about 28.63 lakh hectares constituted the net irrigated area and the balance area of 22.37 lakh hectares is under rainfed. Rainfed agriculture is considered as a gamble with monsoon while soil in these regions is not only thirsty but also hungry. Rainfed agricultural scenario is influenced by both bio-physical and socio-economic factors and their interaction. Uncertain rainfall, growing water scarcity, rising input costs and stagnant output prices have rendered many of the current crop and livestock enterprises in rainfed areas non-remunerative (Ref. [6]). Further, as the labour force is not finding enough work in the villages, they are migrating to long distances in search of work; as rainfed areas are mostly mono-cropped and provide work for four to five months only. Dry land mechanization is emerging as major thrust area for sustainability of dry land farming in India. Research in dry land areas has demonstrated 2-5 times higher productivity potential with timely and precise operation (Ref. [2]). Human and animal power sources are diminishing at faster rate and its being replaced by tractive power. This change in power scenario and necessity of shift towards precision machinery has created the new challenge and possibility for the introduction of new machinery suitable for the dry land crops.

Chisel Plough

Chisel ploughs are used to break through and shatter compacted or otherwise impermeable soil layers. Deep tillage shatters compacted sub soil layers and aids in better infiltration and storage of rainwater in the crop root zone. The improved soil structure also results in better development of root system and the yield of crops and their drought tolerance is also improved. The functional component of the unit includes reversible share, tyne (chisel), beam, cross shaft and top link connection. Chisel plough consists of heavy chisel type tyne which is pulled through the soil normally at a depth greater than that at which conventional ploughing would be done and bursting up the underlying layers of soil without bringing the sub-soil to the surface. The tynes of the implement are sturdy and strong enough to withstand the stresses applied when they are working at depth where the soil conditions are hardened. The implement frame is also strongly constructed usually of box section steel to withstand the stresses applied. The chisel plough has a sturdy but light structure made of 3 mm thick hollow rectangular tubular mild steel sections. The share has a lift angle of 20-degree, width of 25 mm and a length of 150 mm. The implement is protected by a shear pin, which prevents damage from over loading. The implement could be used for deep tillage upto a depth of 40 cm. The coverage is 1.4 ha/day when operated at a spacing of 1.5 m between rows. The cost of the implement is Rs.15,000/-.

Laser Guided land Leveler

The laser system is of quite recent origin. The levelling of land is done precisely with the automatic functioning of the laser-operated scraper. With the laser system the reference plane is generated above the ground with the help of a rotating transmitter in the form laser beam. The scraper is controlled by the laser beam, through a control panel and a solenoid valve, to maintain a desired level by raising or lowering the cutting edge of the blade automatically depending upon the field grades. The tractor operator constantly receives the signals regarding high or low spots as well as on grade information on the control box located in the cabin as well as on the light display fitted in front of operator. The transmitters have usually a recommended working range of 325 meters radius. The laser-controlled system consists of laser transmitter, laser receiver, laser plane receiver, control box, twin solenoid hydraulic control valve and drag Scrapper. The field capacity of the laser leveler is 1.7 ha/day. The cost of the laser guided leveler is Rs. 3,50,000.

Tractor Operated Check Basin Former

A tractor operated check basin former has been developed by MPKV, Rahuri (Ref. [3]). The machine scrapes, collects and distributes the collected soil uniformly to form side bunds and cross bunds at regular interval of 6 m in a single pass. The size of check basin formed is 2 x 6 m. The effective field capacity of the machine is 1.5 ha/day and approx. cost of machine is Rs. 75,000/-.

Conclusion

All the above machinery helped to retain soil moisture longer thereby reducing the irrigation demand which is most essential for dry land agriculture. Though much emphasis is given for dry land mechanization, the results are not up to the mark due to non-profitability. Use of improved farm implements and machinery can enhance inclusive growth of farmers in dry land through increased crop yield and reduced cost of operation and custom hiring service makes the implements accessible to the farmers at affordable rental price. Selection of most appropriate developed equipment for specific situation is essential in respect of field requirements, sol working condition. The farm machinery suitable for dry land for conservation agriculture have the potential to meet the contemporary challenges and to increase productivity in sustainable way.

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Seed Production Technology of Sesame for Western Uttar Pradesh Region

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R. P. Singh[1], Amit Tomar[1], A. K. Mishra[1], S. P. Singh[1], Prachi Patel[1], H. H. Khan[1]
[1]ICAR-Krishi Vigyan Kendra, Gajraula, Amroha, (Directorate of Extension), Sardar Patel University of Agriculture & Technology, Meerut, U.P.

Introduction

Gingelly (*Sesamum orientale*) belonging to the family Pedaliaceae is one of the oldest oil seed crops cultivated for culinary and medicinal needs. Seed production can be done in all the three seasons - rabi (October - November), kharif (June - July) and summer (February - March). It is grown in the country well over 36% of the total acreage and contributes about 25% of the total output.

Importance & Utility

It is rich in oil (50%) and protein (18-20%). Nearly 73% of the oil is used for edible purposes, 8.3% for hydrogenization, 4.2% for industrial purposes in the manufacture of paints, pharmaceuticals and insecticides. India exports sizeable quantity of sesame seeds to different countries. Seeds are eaten fried and mixed with sugar and in several forms in sweet meats. Sesame oil is an important cooking oil in south India. Lower grades of oil are used in soap making industries. It also finds a number of medicinal uses. The oilcake is an edible cake. It is also used as cattle feed especially for milch animals. It can be used as a manure. Cake contains 6.0-6.2% N, 2.0-2.2% phosphorus and 1.0-1.2% of potash. **(Richharia, 1940).**

Method of Seed Production

Gingelly is a cross pollinated crop and seeds are allowed to set by open pollination and then multiplied. The seed crop should be raised in isolation and the isolation distance maintained between varieties is 50 meters for certified and 100 meters for foundation seed production.

Seed Production Stages

Breeder seed → Foundation seed → Certified seed.

Land Selection

The land selected should not be cultivated with the same crop in the previous season. The land should be fertile with proper drainage facility.

Seed Selection and Sowing

Good quality certified seeds should be sourced from an authorized dealer. Seeds should be healthy with a good germination percentage. Seed rate is 2 kg/acre (5 kg/ha). Selected seeds should be treated with bio-control agents like *Trichoderma viride* @ 4 g/kg of seeds. Mix *Trichoderma viride* in rice gruel and mix the solution with seeds. Shade dries the seeds for 30 minutes before sowing. Soaking the seeds in hot water at 52oC for 30 minutes before sowing will control the bacterial leaf spot disease. Treated seeds should be mixed with ash or fine sand to increase the volume for easy sowing. Seeds can be sown in beds and channels or in ridges and furrows. The spacing maintained is 60 x 30 cm (11 plants / m2).

Nutrient Management

FYM or compost @ 4 tonnes/acre (10 tonnes/ha) is thoroughly incorporated into the soil before the last plough. This will improve the texture as well as the nutrient content of the soil. To improve the nitrogen content of the soil green manuring with subabul @ 2 tonnes/acre (5 tonnes/ha) should be done or castor cake or neem cake @ 400 kg/acre (1 tonne/ha) should be applied. *Trichoderma viride* @ 1.5 kg/acre mixed with 300 kg compost and kept as such for one week is applied to the field as top dressing. It will protect the crop from root rot and pathogens like *Pythium* and *Phytophthora*. In prolonged dry condition top dressing can be done using vermiwash. Rainfed sesame requires 17 kg of nitrogen, 13 kg of Phosphorous and 13 kg of Potassium, whereas the irrigated crop requires 21, 23 and 23 kg respectively. Appropriate biofertilisers can be used to meet the nutritional need of the crop.

Weed Management

Sesame is very sensitive to weed competition during the first 25 days after sowing. The first weeding is done 20 days after sowing followed by the second one in 15 days interval. Another weeding may be done in 15 days gap. Apart from hand weeding, implements such as hand hoe, bullock drawn blade harrow, rotary or finger weeders are used for weeding.

Pest and Disease Management

Gingelly is commonly affected by pest and diseases like leaf and pod caterpillar, gall fly, sphinx or hawk moth, wilt, phyllody, stem and root rot and bacterial leaf spot at different growth stages. For control of caterpillars, gall fly and leaf roller, dust 5 per cent BHC dust (20 kg per hectare). For control of blight spray the crop with streptocycline at 0.3 gm in 125 litres of water.

Interculture Practices

Earthing up should be done at the stage of fruit setting to avoid lodging of the crop.

Irrigation

Irrigation should be done once in 15 days. It is critical during flowering and pot filling stage.

Roguing

Roguing should be done from vegetative phase to harvesting phase. Off-types are removed based on the branching type, capsule size and colour of the seeds. Maximum percentage of off-types permitted is 0.10% and 0.20% and permitted percentage of plants affected by seed borne diseases is 0.50% and 1.0% for foundation and certified seed production respectively.

Field Inspection

A minimum of three field inspections should be done from pre flowering stage to harvesting stage by the Seed Certification Officer. First inspection is done before flowering followed by the second inspection during flowering stage. The third inspection is scheduled between fruit maturity and harvest.

Table-1: Field standards:

Field Standard of Sesame	FS	CS
Isolation Distance	100	50
Off-Types	0.10	0.20
Plants Affected by Seed Borne Disease	0.50	1.00

Harvesting

Harvesting should be done when 75 – 80% of the pods become brown in colour and few at the bottom have dehisced (burst open). At this stage the moisture content of the pods and seeds will be 50 – 60% and 25 – 30%, respectively. For black seeded variety, check the colour of the seeds in the 10th capsule from the bottom of the crop. If the seeds are black in colour then harvest should be done. Delaying harvest may result in yield loss.

Stacking and Drying

The harvested plants are stacked upright in the threshing yard for a period of three days. This will help the immature pods in the terminal edge to mature and also help in drying of the pods. The moisture content of the pods will reduce to 9%.

Threshing and Processing

Threshing is carried out manually by beating the capsules with pliable bamboo sticks. The seeds removed from the pods are graded using round perforated metal sieves of 5/64" size.

Seed Storage

Seeds are dried under the sun for 3-4 days to reduce the moisture content to 5.0% before storage. After proper drying the seeds should be mixed with activated clay @ 1 kg/100 kg of seeds. Seeds are then stored in gunny bags or bins. Seeds can be stored upto one year under open storage conditions.

Seed Standards

The percentage of physical purity of foundation and certified seeds should be 97% with 80% of germination capacity and 9% of moisture content. The maximum presence of seeds of other crops and weeds should be 10/kg for foundation and 20/kg for certified seeds.

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Role of Various Sectors in Seed Marketing in India

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Gagandeep Singh[1], Rahul Kumar[1], Shivani[1]
[1]Ph.D. Scholar, Chaudhary Charan Singh Haryana Agricultural University, Hisar.

Introduction

Seed marketing is one of the most vital components of seed technology. On it depends the size and scope of the seed industry. Broadly it includes activities such as production, processing, storage, quality control and marketing of seeds. In the narrow sense, however; seed marketing refers to "the actual acquisition and selling of packed seeds, intermediate storage, delivery and sales promotional activities".

According to ISF (International Seed Federation) and industry consultant report, the global seed market value increased from the $12 billion in 1975 to the $53.8 billion in 2014, which is 3.5 times growth over the last 40 years. In the 5 years 2015-2020, the global seed market is foreseen to maintain fast growth, being expected to arrive at 9.4% CAGR to reach $92 billion in 2020 (IMARC). Country Statistics suggests that the top 10 ranked countries are USA, China, France, Brazil, Canada, India, Japan, Germany, Argentina and Italy. The total market value of the top 10 amounts to $42 billion accounting for 78% of the world total, which shows a high degree of centralization of planting area. The traditional North American market and the emerging Asia Pacific market are developing in parallel. Growth of Indian Seed Industry is on an average 12-14%. The Indian seed market is almost exclusively supplied by domestically produced seeds except for very little quantity of hybrid vegetables (Dravid 2011). The Indian seed industry, over the years, has evolved by adopting and innovating upon scientific advancements in variety development and quality seed production. The industry has grown at a rapid pace of 20.59% over the period 2010-2015 and reached Rs.166.37 billion in 2016 on account of rapid adoption of Bt cotton hybrids, single cross corn hybrids and hybrid vegetables (ICFA, 2016).

In India, large portion of seed trade involves local exchange of established varieties or farmer bred seeds. Ayyappan and Kochhar (2010) reported that more than 70 percent seed usage in India, particularly for food crops is through the farm-saved seed. Studies made by several researchers (Gadwal 2003; Patil et al., 2004; Hanchinal et al., 2009) suggests that with high-volume low-value seeds, such as wheat, groundnut, soybean and chickpea, 75% of the cropping area is sown with farm-saved seeds of old and obsolete varieties. Public sector involvement in the seed industry on a national scale began at the beginning of the "green revolution" with the establishment of the National Seed Corporation (NSC) in 1963. The role of public sector seed companies is now mostly confined to certified seeds of high volume, low value segment of high yielding varieties of cereals, pulses, and cotton.

The public sector seed companies, however, lag behind in research; they are mostly dependent on public research institutions, under the aegis of Indian Council of Agricultural Research (ICAR). At present, it is undertaking production of certified seeds of nearly 600 varieties of 60 crops through its registered seed growers.

Its role extended to several developmental programmes including training, quality control and extension activities in seeds. Although private seed companies such as Poacha and Sutton have been established since the pre-independence era, the accelerated growth of the private sector began only after the introduction of the new seed policy in 1988 which ushered in a liberal business climate. The private sector share about 70% of total marketed seed in India.

Conclusion

The Indian seeds market is anticipated to grow at a considerable CAGR rate due to improvement of seed replacement rate, production and distribution of quality seeds appropriate to agro-climatic zone at affordable prices along with a determined effort to address region specific constraints. Moreover, several factors, including increased subsidies and renewed government thrust on the use of high yielding varieties, will lead to an increased productivity in the seed market.

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Seed Production Technology of Finger Millets in India

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A. K. Mishra[1], S. P. Singh[1], Amit Tomar[1], H. H. Khan[1], Prachi Patel[1], R. P. Singh[1]
[1]ICAR-Krishi Vigyan Kendra, Gajraula, Amroha, (Directorate of Extension), Sardar Patel University of Agriculture & Technology, Meerut, U.P.

Introduction

Finger millet is an annual robust grass, mainly grown as a grain cereal in the semi-arid tropics and subtropics of the world under rain-fed conditions. It is a staple food crop in the drought prone areas in the world, and is considered as an important component of food security. Finger millet grain can be stored for years without storage pests, which makes it a perfect food grain commodity for famine-prone areas. While grains are used for human consumption, the crop residues are excellent source of dry matter for livestock especially in dry season. Finger millet straw makes good fodder and contains up to 61% total digestible nutrients.

Origin

Finger millet is believed to have been domesticated in the highlands of East Africa about 3000 B.C., and in the same period it was introduced in India; origins for the crop can therefore be linked to Africa and India. Finger millet was domesticated in the East African highlands. Cultivation of finger millet spread across the eastern and southern African savanna during the expansion of iron working technology, to eventually reach South Africa some 800 years ago. Finger millet reached India 2000–3000 years ago. From India it spread across South- East Asia to China and Japan. In the United States it is grown on a small scale for bird-seed.

Adaptation

Among millet crops, finger millet figures prominently; it ranks fourth in importance after sorghum, pearl millet and foxtail millet. Finger millet cultivation is more widespread in terms of its geographical adaptation compared to other millets. It has the ability to withstand varied conditions of heat, drought, humidity and tropical weather. It is an important staple in many parts of eastern and southern Africa, as well as in South Asia. The crop is productive in a wide range of environments and growing conditions, from southern Karnataka state in India to the foothills of the Himalayas in Nepal, and throughout the middle-elevation areas of Eastern and Southern Africa.

Morphological Description

Finger millet is a tufted annual crop, growing to a height of 30–150 cm and maturing in 75–160 days. Leaves are narrow, grass-like and capable of producing many tillers and nodal branches. The panicle consists of a group of digitally arranged spikes often referred to as fingers. The spikelets are made up of 4–10 florets arranged serially on the finger. All florets are perfect flowers with the exception of the terminal ones which may sometimes be infertile. The grain is oblong to round and oval, reddish brown in colour with the grains' surface finely corrugated. Typically, a tropical, rain-fed crop, it is one of the best suited for dry farming. Finger millet is very adaptable and thrives at higher elevations than most other tropical cereals.

Flowering and Anthesis

Complete emergence of inflorescence in finger millet required about 10 days and flowering attains 7-8 days. The flower open between 1 to 5 AM and progress from top to bottom in a finger, however, in a spikelet the order is reversed and proceeds from bottom to top and bigger to smaller flower. The stigma is receptive for a very short period after its emergence from the glumes. The period of anthesis being very short, is conducive for self-pollination and cross pollination is very rare.

Seed Production

The best season for seed production is December – January. Pollination should not coincide with rains for quality and effective seed setting. The temperature of 37°c is favourable for seed setting.

Crop improvement and varieties released:

Table-1: List of varieties recently developed along with its characteristics:

Variety	Year of release	Maturity (Days)	Yield level Kg/ha	Area of Adaptation
GPU 66	2013	115-120	4000-4500	Karnataka, Jharkhand, Maharastra, Tamil Nadu, Uttrakhand Chattisgarh,
KMR 301	2009	120-125	3000-3500	Karnataka
VR 847	2009	110-115	3000-3500	Andhra Pradesh
GPU 67	2009	115-120	4000	Karnataka, Chattisgarh, Jharkhand, Maharastra, Tamil Nadu and Uttarakhand.
GPU 48	2005	100-105	3000-3500	Karnataka
TNAU 946	2004	105-115	2000-2500	Tamil nadu
VL 315	2004	105-115	2600-2800	Uttaranchal
GPU 45	2001	104-109	2700-2900	Gujarat, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra
Chilika (OEB 10)	2001	120-125	2600-2700	Orissa, Madhya Pradesh, Gujarat, Andhra Pradesh and Tamil Nadu
GPU 26	2000	100-105	3000-3500	Karnataka
BM 9-1	1999	103-105	2500-3000	Karnataka, Andhra Pradesh, Orissa, Madhya Pradesh & Maharashtra
L-5	1999	120-125	3500-4000	Karnataka
Champavathi (VR 708)	1998	90-95	2000-2500	Andhra Pradesh, Uttar Pradesh, Tamil Nadu, Karnataka, Orissa
MR 1	1998	125-130	3500-4000	Karnataka
PR 230 (Maruthi)	1998	90-100	2500-3000	Andhra Pradesh (Telangana region)
GPU 28	1996	110-115	3500-4000	Karnataka
Birsa	1996	110-115	2000-2500	Chotanagapur regions of Jharkand

marua 2				
VL-146	1995	100-105	2500-3000	Andhra Pradesh
BM 2	1995	105-110	2400-2600	Bihar
Dapoli 1	1994	100-110	1500-2000	Konkan regions of Maharashtra
Suraj (VR 520)	1994	90-95	2200-2800	All over India
KM 65	1994	98-102	1800-2100	Uttar Pradesh
A 404	1993	110-115	2200-2500	Bihar
Gautami (PR 1158-9)	1993	115-120	2800-3000	Andhra Pradesh
GN 3	1993	130-136	2200-2500	Gujarat
Padmavathi (PPR 2350)	1993	110-115	2500-3000	Coastal Andhra Pradesh
Indaf 15	1991	110-115	3500-4000	Karnataka
VL 149	1991	98-102	2000-2500	All states
Saptagiri (PR 2614)	1990	105-110	2500-3000	Tamil Nadu, Maharashtra, Orissa, Andhra Pradesh
KM 13	1989	95-110	2500-3000	Uttar Pradesh, Madhya Pradesh, Orissa
PES 400	1989	98-102	1800-2000	Hills of U.P
Co 13	1989	110-120	2500-3000	Tamil Nadu
TRY 1	1989	100-105	2000-2500	Tamil Nadu
VL 124	1989	95-100	2000-2500	Hills of U.P
RAU 8	1989	105-110	2200-2500	Bihar and other states
Gujarat nagli 2 (NS 109)	1988	110-115	2500-3000	Gujarat
Indaf 9	1988	100-105	3000-3500	Karnataka
HR 911	1986	110-115	4000-5000	Karnataka
Indaf 8	1986	115-120	3500-4000	Karnataka

Field Standards

Ragi is a self-pollinated crop and should be raised in isolation. The isolation distance maintained between the varieties is 3 metres for both foundation and certified seed production to maintain the varietal purity.

Seed Standards

The percentage of minimum physical purity of certified and foundation seeds should be 97% with a minimum of 75% of germination capacity and 12% of moisture content. The presence of inert matter should not exceed 2.0%.

Table-2: Field standards for seed certification in finger millet:

Field standards	Foundation seed	Certified seed
Minimum field inspection (number)	3	3
Minimum isolation distance (metres)	3	3
Maximum off-type (%)	0.05	0.10
Maximum objectionable weeds (%)	-	-
Maximum different crop plants (%)	-	-
Maximum objectionable diseases (%)	-	-

Table-3: Seed standards for seed certification in finger millet:

Seed standards	Foundation seed	Certified seed
Minimum physical purity (%)	97	97
Maximum inert matter (%)	2	2
Maximum other distinguishing varieties (number/kg)	-	-
Maximum other crop seed (number/kg)	10	20

Maximum other weed seed (number/kg)	10	20
Maximum objectionable weeds (number/kg)	-	-
Maximum objectionable diseases (percentage by number)	-	-
Minimum germination (%)	75	75
Maximum moisture (%)		
Ordinary container	12	12
Vapour proof container	8	8

Land Selection
Ragi can be grown in poor to fertile soil. The crop can tolerate salinity better than any other crops. The selected land should be free from volunteer plants. The land should not be cultivated with same crop in the previous season. Land should be ploughed 2 - 3 times to get fine tilth and levelled.

Raising of Nursery (Irrigated Transplanted Crop)
For raising seedlings to plant one ha of main field, select 12.5 cents (500 m2) of nursery area near a water source, where water does not stagnate. Mix 37.5 kg of super phosphate with 500 kg of FYM or compost and spread the mixture evenly on the nursery area. Plough two or three times with a mould board plough or five times with a country plough. Form raised beds by marking units of 6 plots each of size 3 m x 1.5 m. Provide 30 cm space between plots for irrigation. Excavate the soil from the interspace and all around to a depth of 15 cm to form channels and spread the soil removed from the channels on the bed and level.

Pre-Treatment of the Seeds with Fungicides
Seed treatment with Azospirillum may be done @ 3 packets/ha (600 g/ha) and 3 packets (600 g/ha) of Phospho-bacteria or 6 packets of Azophos (1200 g/ ha). Mix the seeds in a polythene bag to ensure a uniform coating of seeds with Thiram 4 g/ kg or Captan 4 g/kg or Carbendazim 2 g/kg of seeds. Form Raised Bed of size 3 m x 1.5 m.

Sowing
Make shallow rills not deeper than one cm on the beds by passing the fingers vertically over them. Broadcast 5 kg of treated seeds evenly on the beds. Cover the seeds by levelling out the hand lightly over the soil. Sprinkle 500 kg of powdered FYM over the beds evenly to cover the seeds which are exposed and compact the surface lightly. Do not sow the seeds deep as germination will be adversely affected.

Irrigation
Adjust the frequency of irrigation according to the soil type. Provide one inlet to each nursery unit. Allow water to enter through the inlet and cover all the channels around the beds. Allow the water in the channels to raise till the raised beds are wet and then cut off water. One irrigation is given on the 3rd day in the case of red soil to soften the hard crust formed on the soil surface and also to facilitate seedlings to emerge out. Do not allow cracks to develop in the nursery bed by properly Pull-out seedlings on the 17th to 20th day of sowing for planting adjusting the quantity of irrigation water.

Table-4: Irrigation requirements for different type of soils:

No. of irrigations	Red Soils	Heavy Soils
1st	Immediately after sowing	Immediately after sowing
2nd	3rd day after sowing	4th day after sowing
3rd	7th day after sowing	9th day after sowing
4th	12th day after sowing	16th day after sowing
5th	17th day after sowing	..

Preparation and Management of Main Field
Plough twice with mould board plough or thrice with wooden plough till a good tilth is obtained. Spread 12.5 t/ha of FYM or compost or composted coir pith evenly on the unploughed field and then plough and incorporate in the soil. Apply NPK fertilizers as per soil test recommendation as far as possible. If soil test recommendation is not available, adopt a blanket recommendation of 60 kg N, 30 kg PO5 and 30 kg K2O5

per ha. Apply half the dose of N and full dose of N and full dose of P2O5 basally before planting. Broadcast the fertilizer mixture over the field before the last ploughing and incorporate into the soil by working a country plough. Apply 10 packets/ha (2000 g) of azospirillum and 10 packets (2000 g/ha) of Phosphorous solubilizing bacteria or 20 packets of Azophos (4000 g/ha) after mixing with 25 kg of soil and 25 kg FYM before transplanting.

Transplanting

Let water into the bed, level the bed, if it is not levelled. Plant 2 seedlings per hill. Plant the seedlings at a depth of 3 cm. Plant 18 to 20 days old seedlings. Adopt a spacing of 30x10 cm for planting. Adopt 22.5 x 10 cm spacing for direct sowing. Root dipping with Azospirillum prepare slurry with 5 packets (1000 g)/ha of Azospirillum and 5 packets (1000g/ha) of Phospho-bacteria or 10 packets of Azophos (2000 g/ha) in 40 litres of water and dip the root portion of the seedlings in the solution for 15-30 minutes and transplant.

Weed Management

The seed production field should be maintained weed free from the initial stage. For chemical weed control, apply PE Oxyfluorfen @ 0.05 kg a.i/ha on 3 DAS using Backpack Knapsack/Rocker sprayer fitted with flat fan type of nozzle with 500 litre of water/ha followed by one hand weeding on 20 DAS. Apply the herbicides when there is sufficient moisture in the soil or irrigate immediately after application of herbicide. If pre-emergence herbicide is not applied, hand weed twice on 15th and 30th day after transplanting. After hand weeding allow the weeds to dry for 2–3 days.

Hoeing and Hand Weeding

Hoe and hand weed on the 15th day of planting in light soils and 17th day of planting in heavy soils and subsequently on 30th and 32nd days, respectively. Allow the weeds to dry for 2 or 3 days after hand weeding before giving irrigation. Do not adopt hoeing and hand weeding if herbicide is applied.

Harvesting

Ragi crop does not mature uniformly and hence the harvest is to be taken up in two stages. When the ear head on the main shoot and 50% of the ear heads on the crop turn brown, the crop is ready for the first harvest. Seven days after the first harvest, cut all the ear heads including the green ones. Cure the grains to obtain maturity by heaping the harvested ear heads in shade for one day without drying, so that the humidity and temperature increase and the grains get cured. Dry, thresh and clean the grains by winnowing and store the grains in gunnies.

Threshing

Green ear heads if harvested will contaminate the seeds with immature seeds and interfere cleaning, drying and grading. Dry ear heads until seed moisture content is 15% and separate manually by threshing with bamboo stick or machine thresher. Threshed seeds should be precleaned before sun drying, seeds must be dried to 12% before grading. Admix one kg of Activated kaolin or Malathion 5% D for every 100 kg of seed. Pack in gunny or polythene lined gunny bags for storage.

Drying and Storage

The cleaned seeds should be sun dried to attain a safe moisture level of 12%. Care should be taken while drying to avoid mechanical injury to the seeds and contamination. Seeds can be stored upto 13 months under proper storage conditions.

Crop Diseases and Pests Management

Finger millet is affected by pests and diseases like pink stem borer, aphids, root aphids, ear head caterpillars, blast, brown spot, mottle streak virus etc., at different growth stages. To control root aphids, mix Dimethoate 3 ml in one litre of water and drench the rhizosphere of the infested and surrounding plants with the insecticidal solution. For the control of blast disease, choosing resistant variety and treating seeds with carbendazim @ 2 g/kg seed effectively controlled the blast incidence and resulted in higher yield. Spraying of SAAF @ 0.2 % at 50% flowering and one more need based spray after 10 days is also effective in controlling neck and finger blast.

Smut

Since the disease is mainly seed-borne, it can be controlled by treating the seed with organomercurials or steeping the seed for 10 to 30 minutes in 2 per cent copper sulphate solution or 0.5 per cent formalin for about 30 minutes. Apply VAM culture (*Glomus fasciculatum*) at 100 g/m2 in the nursery and also treat with Azospirillum and Phospho-bacterium as seed treatment, seedling dip and field application to reduce the reniform nematode population in finger millet.

Monkeypox: Immunity and Nutrition

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Kumari Mona[1], Gupta Alka[1]
[1]Research Scholar, Assistant Professor, Department of Food Nutrition and Public Health, Ethelind College of Home Science, SHUATS, Prayagraj, Uttar Pradesh, India.

Abstract
The world is currently facing its largest-ever outbreak of monkeypox in non-endemic countries, which began in May of 2022. Monkeypox is a viral disease that is related to smallpox. The virus can be spread through close contact with infected animals or individuals, or through respiratory droplets or bodily fluids. Symptoms include fever, headache, swollen lymph nodes, muscle and back aches, and fatigue. The rash starts as red spots and evolves into fluid-filled raised bumps before scabbing over and healing. Little is known about human immunity to monkeypox, including the usefulness of vaccine immune globulin (VIG) made from smallpox vaccine recipients. Nutritional supplementation is considered a crucial intervention, particularly for children, and a standard tool is used to assess malnutrition in adults.

Keywords: monkeypox, transmission, swollen lymph nodes, muscle aches, MPXV, smallpox, vaccine immune globulin (VIG), supplementation, intervention.

Introduction
Monkeypox, a viral disease that is transmitted to humans from animals and has symptoms similar to smallpox. Monkeypox is a significant public health concern in central and western Africa, and it is becoming more common in urban areas. The disease is primarily spread by rodents and non-human primates, and the first outbreak outside of Africa occurred in the US in 2003. In recent years, cases of monkeypox have been identified in several countries, and research is being conducted to better understand its epidemiology, sources of infection, and transmission patterns. Monkeypox has become more significant since the cessation of smallpox vaccinations.

Transmission and Shedding of the Monkeypox Virus
Various animal species are susceptible to monkeypox virus, including wire squirrels, tree squirrels, Gambian kangaroos, parasites, non-human primates, and others. Transmission to humans occurs through direct contact with infected animals' blood, body fluids, skin, or mucous membranes. Although monkeypox's natural reservoirs are unknown, rodents are thought to be the most likely carriers. Eating undercooked meat or animal products from infected animals may pose a risk, particularly for individuals residing in or near forested areas who may have indirect or low-level contact with infected animals.

Person-to-person transmission of monkeypox can occur through close contact with respiratory secretions, skin sores, or contaminated objects. Healthcare professionals, family members of patients, and close contacts of active cases are at a higher risk of contracting the disease. The longest chain of human-to-human transmission has increased from 6 to 9, possibly due to the discontinuation of smallpox vaccination and a decrease in immunity. Monkeypox can also be transmitted congenitally, and it is currently unknown whether sexual contact is a mode of transmission. More research is needed to better understand the risks of transmission.

Signs and Symptoms of Monkeypox
Monkeypox has an incubation period of 5 to 21 days and is characterized by two phases. The first phase, lasting 0-5 days, includes symptoms such as fever, headache, swollen lymph nodes, back pain, myalgia, and lack of energy. Swollen lymph nodes are a distinguishing feature of monkeypox. The second phase, which typically appears 1-3 days after the onset of fever, is characterized by a rash that affects the face and extremities more than the trunk. The rash progresses through several stages, from patches to papules, vesicles, pustules, and finally dry scabs. The rash can also affect the palms, soles, oral mucosa, genitals, and conjunctiva, and in severe cases, large portions of skin may slough off.

Monkeypox is a self-limiting disease with symptoms lasting for 2-4 weeks. Severe cases are more common in children and can be associated with virus exposure, the patient's health, and underlying immunological deficits. Discontinuation of smallpox vaccination campaigns has made younger people more susceptible to monkeypox. Complications of monkeypox can include corneal infection, bronchopneumonia, sepsis, encephalitis, and blindness. The fatality rate of monkeypox historically ranged from 0 to 11%, but nowadays it is around 3-6%. The prevalence of asymptomatic infections is currently unknown.

Immunity and Health

Immunity is an important factor in the prevention and control of monkeypox. The smallpox vaccine, which provides some protection against monkeypox, has been discontinued after the eradication of smallpox, leading to a decline in immunity among populations and a rise in monkeypox cases. Although human immunity to monkeypox virus (MPXV) is not well understood, investigations using related orthopoxviruses and the smallpox vaccine are commonly used to gain insights. Vaccine immune globulin (VIG) derived from smallpox vaccine recipients' antibodies is used to treat smallpox, but its effectiveness against MPXV is uncertain and should be studied further with prospective data collection.

Monkey Pox and Nutrition

In addition to immunity, proper nutrition and hydration are essential for the prevention and control of monkeypox. Patients with monkeypox should be evaluated for their nutritional and hydration status and receive adequate nourishment and rehydration. Nutritional supplementation is a crucial intervention, and standard tools can be used to assess malnutrition in both adults and children. Daily oral nourishment should be promoted, and if the patient is healthy enough for oral food intake, nutrient-dense therapeutic foods should be offered. Vitamin A supplements should also be provided according to standard recommendations, particularly for children. If food intake is not tolerated, the cause should be determined and treated accordingly. Pain caused by oral lesions or cervical adenopathy should also be addressed. Proper nutrition is crucial in all stages of wound healing and eye health.

Conclusion

Monkeypox is a viral disease that poses a significant public health threat, especially in urban areas. The disease is primarily transmitted by rodents and non-human primates, with person-to-person transmission possible through close contact. Due to the discontinuation of the smallpox vaccine after the eradication of smallpox, immunity against monkeypox has declined, leading to an increase in cases. Maintaining proper nutrition, hydration, and immunity is crucial in preventing and controlling monkeypox. However, more research is needed to better understand the risks of transmission and to determine the effectiveness of treatments for monkeypox.

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Seed Production Technology of Little Millet in India

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S. P. Singh[1], Amit Tomar[1], A. K. Mishra[1], Prachi Patel[1], H. H. Khan[1], R. P. Singh[1]
[1]ICAR-Krishi Vigyan Kendra, Gajraula, Amroha, (Directorate of Extension), Sardar Patel University of Agriculture & Technology, Meerut, U.P.

Introduction

Little millet (*Panicum sumatrense*) belongs to the family Gramineae. It is grown throughout India with major areas in the states of Karnataka, Andhra Pradesh, Tamil Nadu, Orissa, Bihar, Maharashtra and Madhya Pradesh. Little millet can thrive well upto an elevation of 2100 metres in tropics and subtropics and is photo- insensitive. Little millet originated in Southeast Asia and is nowadays grown throughout India, particularly in Madhya Pradesh, Orissa, Jharkhand and Uttar Pradesh. It is cultivated to a limited extent up to altitudes of 2100 m. The dehusked grain is cooked like rice and eaten. In parts of South India, the grain is processed very similar to the parboiling of rice. Often, roti and porridge are made and consumed. It is also made into flour, used for making puddings or cakes. Another method is to cook cracked grains with vegetables and spices to prepare a food similar to curried rice. Fortification with lysine and heat processing improves protein quality and nutrition. In many tribal areas, little millet is considered as a cash crop as it fetches much higher prices than rice. The straw is thin, soft and cattle consume it readily.

Origin

The origin of this crop is not well documented except for the probable Indian origin since it is endemic to India and has a name in all vernacular languages of India. *Panicum miliare* or little millet is cultivated or naturalized throughout India and Sri Lanka, and cultivated in neighbouring countries. The distribution of the crop is limited to India and little diversity is found elsewhere. The luxuriant presence of *Panicum psilopodium* Trin., a wild relative of little millet in India, is suggestive of Indian origin.

Adaptation

The crop can grow well in drought conditions and considered as a good famine food as it can produce some grain even under severe drought conditions when all the other crops fail to produce. It is a typical dryland crop suitable for the areas with low rainfall and poor soils. Little millet is able to thrive on marginal soils which otherwise yield nothing, and mature as a crop even during famine years. It is a. hardy crop which ran withstand drought better than most of the other cereal crops and also water-logging to a certain degree. If the crop fails, the farmer stands to lose very little as the cost of production as well as the land value is negligible.

Morphology and Anatomy

It is an annual grass, with culm 30-90 cm. high, rather slender, erect or base geniculate, simple or branched; leaves linear 15 to 50 cm. or more in length, 12to 25 cm, broad, gradually tapering from a broad base, glabrous or finely hairy; Sheath- rarely hairy with tubercled base hairs; Ligule- an arrow row of hairs; Node- glabrous; Panicle- very compound, contracted of thyrsiform, often nodding, 15 to 45 cm. long; Spikelet- glabrous, rather flattened, suddenly cuspidate, 3-4.5mm, long, mostly paired on unequal pedicels, but often solitary at the end of the branchlets, lanceolate in flower, elliptic or broadly elliptic in fruit. Glume I- very broadly ovate, subtruncate, then suddenly acute, or scarcely acute, about 1/3 the spikelet, white, membranous, 3-5 nerved, nerves arching and anastomising. Glume II - herbaceous, ovate, lanceolate, 11- 13 nerved, almost as long as the spikelet. Glume III- herbaceous, broadly ovate, 9 nerved, slightly shorter than glume II, palea as long as the glume (3-4 mm.) flower neuter or rarely with 3 stamens. Glume IV- narrow elliptic, or elliptic oblong to broadly ovate, acute, shining white or pale brown or dark brown, often 3-5 streaked dorsally; Fruit- caryopsis enclosed tightly within the fourth glume and its palea (2.5 to 3.5 mm).

Anthesis and Pollination

The hermophrodite flowers which open in basipetallic pattern have brief and rapid anthesis period. The glumes open for not more than 2-3 minutes, and self-pollination is a rule. There is hardly any natural cross pollination. Under Indian conditions, the flowers open between 9 AM and 12 noon. Emasculation and artificial pollination are difficult in view of small flower size but not impossible. Encouraging results have been obtained by the contact method of crossing.

Crop Specific Issues

Little millet is often planted with the onset of monsoon and it is the first crop to be harvested in the season. As a result, they provide precious grain in the lean months. Often these crops are associated with tribal agriculture and has been the preferred crop for extreme soil and climatic conditions because of assured harvests they ensure. Little millet is raised as a pure crop or as a subsidiary crop mixed with other millets like finger millet in Karnataka, or pulses like horsegram, or bengalgram in Tamil Nadu, Orissa and Bihar or with oilseeds like gingelly, soyabean in Madhya Pradesh. Shifting cultivation of little millet was prevalent in many hilly parts of India till few decades ago.

Crop rotation is not feasible since the holding size is small besides soils are poor in nutrients and moisture. In some places it is included in a two-year rotation with horsegram. Little millet - Niger or little millet - mustard crop sequences are popular in Bihar, Orissa and Madhya Pradesh. On an average, little millet yields 600to 800 kg per hectare. With improved production practices the yield levels could be pushed to 1200-1500 kg per hectare.

The husk forms about 20 per cent of the weight of the grain. Little millet grains can be consumed by direct cooking; they can be made into flour and baked to make bread. Both the plants and the straw are often used as forage. The crop can be grown in a wide range of climates and generally thrives well in poor soils and under adverse climatic conditions. The crop cycle ranges from 2.5 to 5 months. Yield ranges from 200 to 600 kg/ha.

Seed Production

Seed production can be done during June – July and February – March. The pollination should not coincide with rains for quality and effective seed setting.

Field Standards

Little millet is a self-pollinated crop and should be raised in isolation. The isolation distance maintained between the varieties is 3 metres for both foundation and certified seed production to maintain the varietal purity.

Table-1: Improved varieties and their characteristics in little millet:

Variety Name	Central/ State	Date of Notification	Adaptation	Maturity duration (days)	Pests and disease reaction	Grain Yield (Kg/ha)
Saura (OLM-208)	Central	2010	Recommended for release and cultivation in the states of Orissa, Chhattisgarh and Gujarat under rainfed upland conditions	71 to 137	Resistant to Blast and moderately resistant to rust, grain smut, sheath blight and shoot fly	1413-3407
Co 4	Tamil Nadu	2007	Low rainfall and low fertile soils in the marginal and sub-marginal, Rainfed dry lands, hill and tribal areas of Tamil Nadu	75 to 80	-	1500
Sabara (OLM-20)	Central	2004	Recommended for release and cultivation for kharif season inUplands of orissa, madhya pradesh and chattishgarh	46 to 77	Moderately resistant to shoot fly. Moderately susceptible to grain smut ; moderately resistant to Sheath blight ; brown spot.	1196 - 2100
Kolab (olm-36)	Central	2001	Recommended for cultivation in MP, Orissa, Chattishgarh, Bihar, Karnataka and Gujarat under rainfed upland condition	77	Moderate resistant to Grain smut and Shootfly, Resistant to brown spot and shoot fly	1091
Tarini (OLM-203)	Central	2001	Recommended for release and cultivation under rainfed upload conditions in the states of Karnataka, Andhra Pradesh,	105 to 115	Resistant to blast and grain smut and moderately resistant to brown spot and shoofly	-

			Orissa, Bihar and Tamil Nadu			
Paiyur-2	Tamil Nadu	2000	Recommended for cultivation in marginal and sub marginal dry land of Tamil Nadu	80-85	Lesser incidence of Grain smut as compared to Co2, Co3 and Paiyur-1	744 to 800
Co-3	Tamil nadu	1997	Recommended for cultivation in rainfed conditions in Tamil Nadu	80 to 85	Tolerant to major diseases and pests.	1066
TNAU-63	Central	1997	Low rain fall and marginal soil areas of Karnataka, Gujarat and Tamil Nadu	69 to 104	Shoot fly incidence (8%), aphids (14%), brown spot (0.5%grade), Smut Incidence (3.4%)	1152
Birsa gundli-1	Central	1993	Upland, rainfed situation of plateau region of Bihar	55-60	-	700 to 800
Paiyur-1	Central	1989	Tropics of South India		-	873
Jawahar Kutki-2	Central	1987	-	75 to 80	-	700 to 1000
Jawahar kutki-8	Central	1987	-	80	Moderately resistant to shootfly	
PRC-3	Central	1986	Recommended for release for cultivation in MP, Orissa,Bihar, Maharashtra & Karnataka	61 to 93	Moderately resistant to shootfly	-
Gujarat Vari-1	Gujarat	1985	-		-	1500
Gariya Band (Din-dori-2)	Madhya Pradesh	1984	-	75 to 80	-	700 to 1000
K-1	Tamil Nadu	1982	-	90 days.	-	1285
Co-2	Central	1978	-	80-85 days.	Fairly tolerant to pests under field conditions	
Dindori-1	Madhya Pradesh	1973	Heavy rainfall tract of maharashtra state	125 to 130	No serious pest or disease observed	1500 to 2000

			especially konkan Region			
Co1	Tamil nadu	1956	-	90 to 100	The incidence of shoot fly is similar to that of other varieties	400 to 500
Jawahar Kutki-36 (2009)	Madhya Pradesh		Suitable for sole and inter-cropping, lodging medium, resistant to drought, responsive to NPK application, seed rate of 10 kg/ha	76	Tolerant to grain smut and shoofly	4600
V-15	Central		Popular in south Bihar and parts of	78 to 80	Moderately resistant to diseases	1400 to 1600
V-17	Central		Popular in south Bihar and parts of Orissa.	78 to 80	Moderately resistant to disease	1400 to 1600

Seed Standards

The percentage of minimum physical purity of certified and foundation seeds should be 97% with a minimum of 75% of germination capacity and 12%of moisture content. The presence of inert matter should not exceed 2.0%.

Table-2: Field standards for seed certification in little millet:

Field standards	Foundation seed	Certified seed
Minimum field inspection (number)	3	3
Minimum isolation distance (metres)	3	3
Maximum off-type (%)	0.05	0.10
Maximum objectionable weeds (%)	-	-
Maximum different crop plants (%)	-	-
Maximum objectionable diseases (%)	-	-

Table-3: Seed standards for seed certification in little millet:

Seed standards	Foundation seed	Certified seed
Minimum physical purity (%)	97	97
Maximum inert matter (%)	2	2
Maximum other distinguishing varieties (number/kg)	-	-
Maximum other crop seed (number/kg)	10	20
Maximum other weed seed (number/kg)	10	20
Maximum objectionable weeds (number/kg)	-	-
Maximum objectionable diseases (percentage by number)	-	-
Minimum germination (%)	75	75
Maximum moisture (%)		
Ordinary container	12	12
Vapour proof container	8	8

Land Selection

Little millet can be cultivated in both rich and poor soils. Well drained loam or sandy loam soils rich in organic matter are ideal for cultivation. The selected land should be free from volunteer plants. The land should not be cultivated with same crop in the previous season.

Seed Selection and Sowing

Seeds used for seed production should be of good quality certified seeds from an authentic source. Seeds should be healthy with required germination percentage. Recommended seed rate is 4 kg/acre (10 kg/ha). Selected seeds should be treated with *Azospirillum* @ 60 gms/kg of seeds. Treated seeds should be sown with a spacing of 30 x 10 cm. Seeds should be sown in June – July at the onset of monsoon rains. Summer crop should be sown in the month of February – March. Seeds are broadcast manually or by seed driller in furrows at a depth of 3 – 4 cm.

Main Field Preparation

The main field should be harrowed for 2–3 times to make it a fine tilth and levelled. The levelled field is formed into ridges and furrows. During final plough apply compost or farmyard manure @ 5 tonnes/acre (12.5 tonnes/ha) and incorporate into the soil. Seeds can be sown in the ridges at a depth 3 - 4 cm with a spacing of 30 × 10 cm.

Nutrient Management

Before final ploughing compost or farmyard manure @ 5 tonnes/acre (12.5 tonnes/ha) should be applied and ploughed into the soil. Instead of this cattle penning can also be practiced. 50 kg neem cake and 500 kg vermicompost per acre (125 kg neem cake and 1250 kg vermicompost per hectare) should be applied as basal manure. For rainfed crop, apply 50 kg/acre (125 kg/ hectare) of pungam cake and 250 kg/acre (600 kg/hectare) of vermicompost as basal manure just before sowing. After first weeding at 20 – 25 days after sowing top dressing should be done using enriched vermicompost (2 kg *Azospirillum*, 2 kg *Phosphobacterium* and 2 litres *Panchagavya* mixed with 250 kg vermicompost and kept covered for a week and then used) @ 250 kg/acre (600 kg/ha). During flower initiation stage 10% tender coconut solution (1 litre tender coconut water + 9 litres of water) should be sprayed. All the above-mentioned inputs should be applied to the rainfed crop only when the soil is wet.

Weed Management

The seed production field should be maintained weed free at least upto 35 days after sowing for retaining the soil moisture and nutrients. Subsequent weeding should be done at an interval of 15 – 20 days. Weeding can be done with handhoe or wheel hoe.

Irrigation

Kharif season crop does not require any irrigation. However, if the dry spell prevails for longer period at least one irrigation should be given at the tillering stage to boost the yield. First irrigation should be given 25 - 30 days after sowing followed by the second one at 40 – 45 days after sowing. Summer crop requires 2 - 4 irrigations depending upon soil type and climatic conditions. During heavy rains the excess water from the field should be drained out.

Roguing

Roguing should be done often to remove the offtypes, volunteer plants and diseased plants from the seed production field to avoid the genetic contamination. Roguing should be done upto the flowering stage. Maximum percentage of offtypes permitted at the final inspection is 0.05% for foundation and 0.10% for certified seed production.

Field Inspection

A minimum of two inspections should be done between flowering and maturity stages by the Seed Certification Officer. The first inspection is done at the time of flowering to check the isolation and off-types and the second inspection is done during the maturity stage prior to harvest to check the off- types and to estimate the yield.

Harvesting and Processing

Harvest is done once the earheads are physiologically mature. Normally crop is ready for harvest in 80 - 85 days after sowing. The crop should be harvested when two thirds of the seeds are ripe. The harvested earheads are threshed by hand or trampling under the feet of bullocks. The threshed grains are further cleaned by winnowing.

Drying and Storage

The cleaned seeds should be sun dried to attain a safe moisture level of 12%. Seeds can be stored upto 13 months under proper storage conditions.

Crop Diseases and Pests Management

There are no major problems of disease and pest incidence in little millet. However, the shootfly incidence is severe in some years which could be controlled by applying carbafuron, preferably alongwith azotobacter bio-fertilizer. Soil application of phorate 1 kg a. i/ha in furrow is also effective in checking shootfly infestation. Rust, caused by Uromyces linearis is reported from India, Sri Lanka and Philippines Islands and it is a minor disease.

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Electroantennogram (EAG) and GC-EAD

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Chaitanya[1]
[1]PhD Scholar, ICAR – Indian Agricultural Research Institute, New Delhi – 110012.

Abstract

Electroantennogram is popular bioassay in experimental entomology for the perception of volatiles detected by an insect's antennal olfactory system. Odors play important role in insect's life like as they influence a variety of insect behaviors and give insects important environmental information. So, it is important to have basic knowledge of EAG set up to study the response of insects to various chemical stimuli under laboratory conditions.

Keywords: Antenna, Electrode, Olfactory appendages.

Introduction

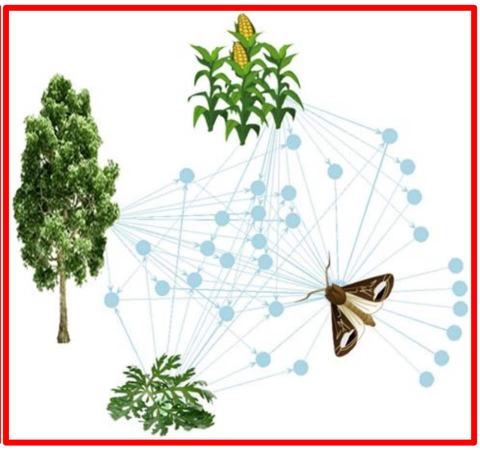
Slow potentials could be recorded from antennal preparations, and the phenomenon was given the name Electro-Antenno-Gram or EAG (Schneider, 1957; Schneider *et al.*, 1967), after analogy of the Electro Olfacto Gram (EOG) and Electro Retino Gram (ERG), all of which are recordings of the responses of many receptor neurons in the organ to the presentation of a stimulus.

A popular bioassay in experimental entomology for the detection of volatiles detected by an insect's antennal olfactory system is electroantennography (EAG). The technique is based on a discovery made by Schneider (1957), who observed minute voltage variations between an insect antenna's tip and base when it was stimulated by pheromones. Although the precise mechanism behind the EAG signal is not known, it is generally assumed that the measured voltage fluctuation is caused by electrical depolarizations of many olfactory neurons in the insect antenna. At rising stimulus concentrations, an EAG response's amplitude grows until it reaches a saturation point. The type of stimulus, the species of insect, its sex, as well as numerous other less clear-cut variables, all have an impact on the amplitude. Due to the lack of a solid theoretical justification, EAG should be viewed as an empirical approach that has some application but doesn't offer any basic information about the physiology of insect olfactory receptor mechanisms. Nevertheless, the practical value is considerable.

The EAG method has a wide range of applications, including the identification of physiologically active fractions, the purification of extracts, the selection of active synthetic compounds, concentration measurements in the field, and usage as a detector in gas chromatography. Technically speaking, TEAG recording is simple and does not need sophisticated equipment. Nevertheless, the quality of EAG signals is dependent on many factors, which are not always well recognized, and the large variety of insects demands a flexible attitude and a sense for improvisation of the operator. The aim of this is to describe the basic methods, give practical tips and hints, provide insight in the instrumental requirements, and to guide the experimental scientists - irrespective of their background - in practical EAG recording. For practical reasons the description of the electrical events and electronic signal processing is presented without unnecessary details, which may seem oversimplified for colleagues familiar with electronics. EAG recording techniques may vary in many specifics, despite the fact that the fundamental concepts remain the same. The wide range of insects and the variations in antennal shape necessitate changes in the recording technique and need an innovative mindset. Finding original publications that address a particular insect or research issue in the literature is highly advised. Although not dealing with modern recording technology a basic review of the application of the EAG technique as a bioassay is presented by Roelofs (1984).

Odor in Insect Life

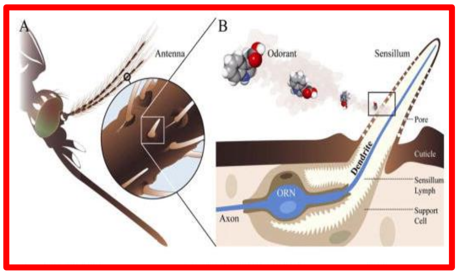
Odorants cause a variety of insect behaviors and give insects important environmental information. VOCs act as chemical indicators to identify and locate essential resources like food, a partner, or foes. Insects must gather this pertinent data from their extremely complicated chemical environment, which they inhabit.

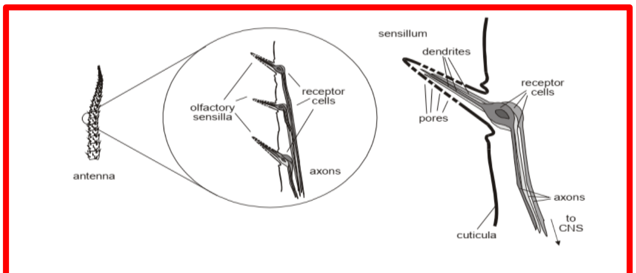


Olfactory Appendages

The antennae, maxillary palps and the proboscis:

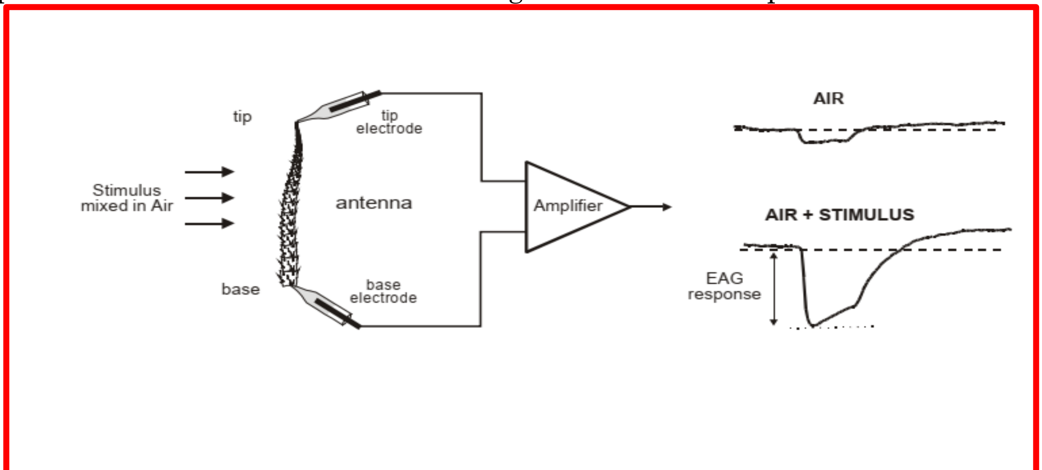
1. Chemosensory detector units are particularly installed in the olfactory hairs of the antenna.
2. An odorant that has entered a sensillum is shuttled by odorant-binding proteins, which unload their cargo on odorant receptors located on the dendritic end of sensitive receptor neurons.
3. Their function is to convert chemical odorants into electrical signals, which is the vocabulary understood by the brain.
4. The brain receives an input signal from the odor-dependent action potentials that travel along the axon from the antennae to the antennal lobe.





Antennal Structure and Arrangement of Olfactory Sensilla

5. Electroantennography (EAG) is a bioassay that is frequently used in experimental entomology, for the detection of volatiles detected by an insect's antennal olfactory system,
6. The method is based on the discovery by Schneider (1957), who recorded small voltage fluctuations between the tip and base of an insect antenna during stimulation with pheromones.



Principle of Electroantennogram (EAG) Recording

7. It is generally assumed that the measured voltage fluctuation is caused by electrical depolarisations of many olfactory neurons in the insect’s antenna. At rising stimulus concentrations, an EAG response's

amplitude grows until it reaches a saturation point. The type of stimulus, the insect's species, its sex, as well as numerous other less clear-cut variables, all have an impact on the amplitude.

The Eag Signal

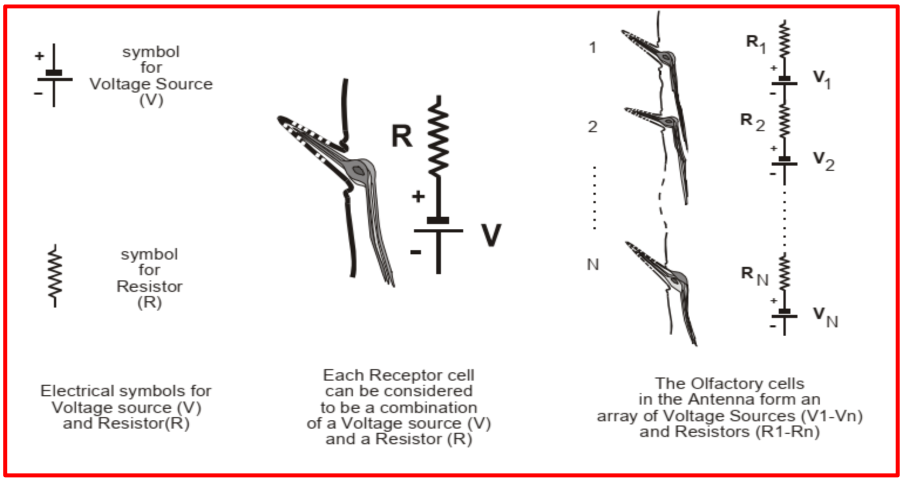


Image courtesy: Syntech, 2015

The EAG signal is a voltage deflection, which can be measured with suitable equipment, between the tip and the base of an insect antenna when exposed to an adequate stimulus.
1. Each olfactory receptor cell can be electrically considered to be a combination of a resistor (R) and a voltage source (V).
2. The whole antenna containing a large number of olfactory cells forms an array of voltage sources and resistors, which in practice can be considered as a single antennal voltage source and an antennal resistance.
3. The antennal voltage source is rather weak and the resistance of the antenna is high, in the order of several mega Ohms (1M=106).
4. This resistance generally increases when the antenna dries out during an experiment. Generally, the tip of the antenna becomes negative with respect to the base. The amplitude of voltage fluctuation may range from a few microvolts (1µV= 10 -6 V) to several millivolts (1mV= 10-3 V).

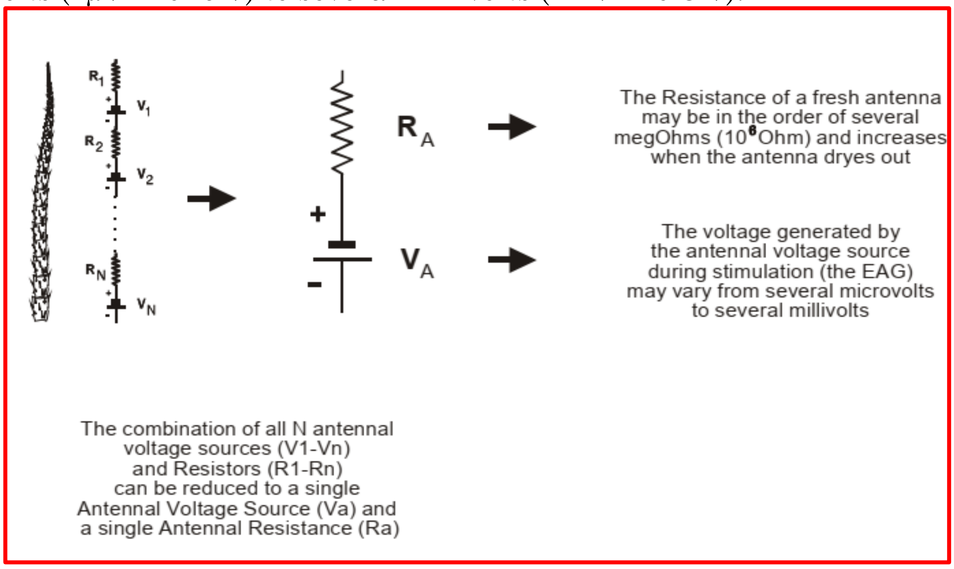


Image courtesy: Syntech, 2015

For a given species and sex of insect the antennal response may be based on various factors:
1. Nature of the stimulus
2. Strength (concentration) of the stimulus
3. Condition of the antenna
4. Life time of the preparation
5. Number and strength of the previous stimulations

6. Quality of the amplifier input
7. Moreover, the response is somewhat influenced by temperature and humidity, and to a lesser extent by the insect's physiological condition.

Basic Instrumentation

Preparing micropipettes for EAG recording contact with the base and the tip of the antenna is generally made by means of glass micropipette electrodes. The use of metal electrodes combined with standard saline solutions is not recommended, because the noise introduced by the electro-chemical potentials developed in these electrodes.

Suitable capillary glass tubes (1 - 2.5 mm outer diameter) are drawn to a fine point using a microelectrode puller, or manually in a flame. Adjusting the tip, the tips of machine-pulled glass micropipettes are too fine for EAG purposes. Use delicate forceps to carefully break off the tips so that the inner diameter is large enough to accommodate the insertion of an excised antenna. The pipette tip should be adjusted while the antenna is being viewed through the stereo microscope.

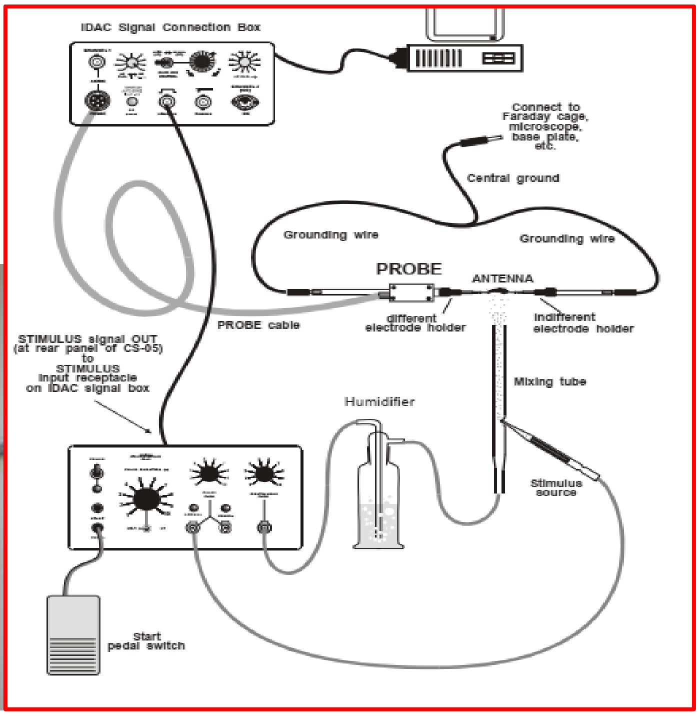
Micropipettes filled with an electrically conductive solution. A solution of 0.1 N KCl is frequently used, however more complicated 'Ringer' solutions for insects can be used. To prevent evaporation of water at the tip of the pipettes causing KCl crystal formation, which may result in bad EAG signals, a small amount (1-5% by volume) of polyvinylpyrrolidone (PVP) can be added to the KCl solution; shake well and let it stand for a while until the solution becomes clear. PVP is a very large molecule (Mol. Wt. 360.000), which prevents evaporation by creating a coating on the surface of the fluid in which it has been dissolved.

Pipettes for EAG work have a relative wide tip; they fill spontaneously when dipped in the saline due to capillary action. Just the first 10 to 15 mm from the tip should be filled. Fill the micropipettes only shortly before making the antennal preparation.

Electrode Preparation

The image on the left shows how to insert a glass pipette, electrode wire, and stainless-steel electrode holders. The body of the different ('recording') electrode, which is mounted onto the probe, is not on ground potential. It is connected to the output of the first operational amplifier inside the probe, thus forming a so called 'guard'. Such a guard circuit constitutes an effective shield against noise interference and eliminates the effect of leakage currents across the input. As the input "window" of the PROBE permits offset voltages up to 400 mV, practise has suggested that AgCl coating is not typically necessary.

Eag Instrument

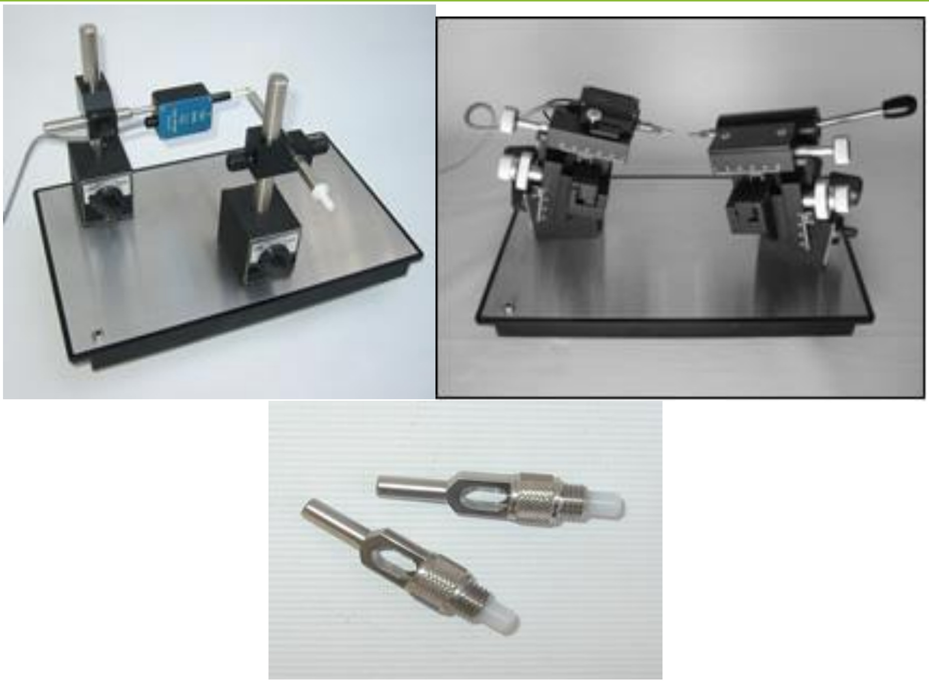


Image courtesy: Syntech, 2015

Preparation of Micropipette

Changing the tip Machine-pulled glass micropipettes' tips are too small for use with EAG. Use delicate forceps to carefully break off the tips so that they have an inner diameter that is large enough to accommodate the insertion of an excised antenna. It is helpful to observe both the antenna and the pipette tip under the stereo microscope while adjusting the tip.

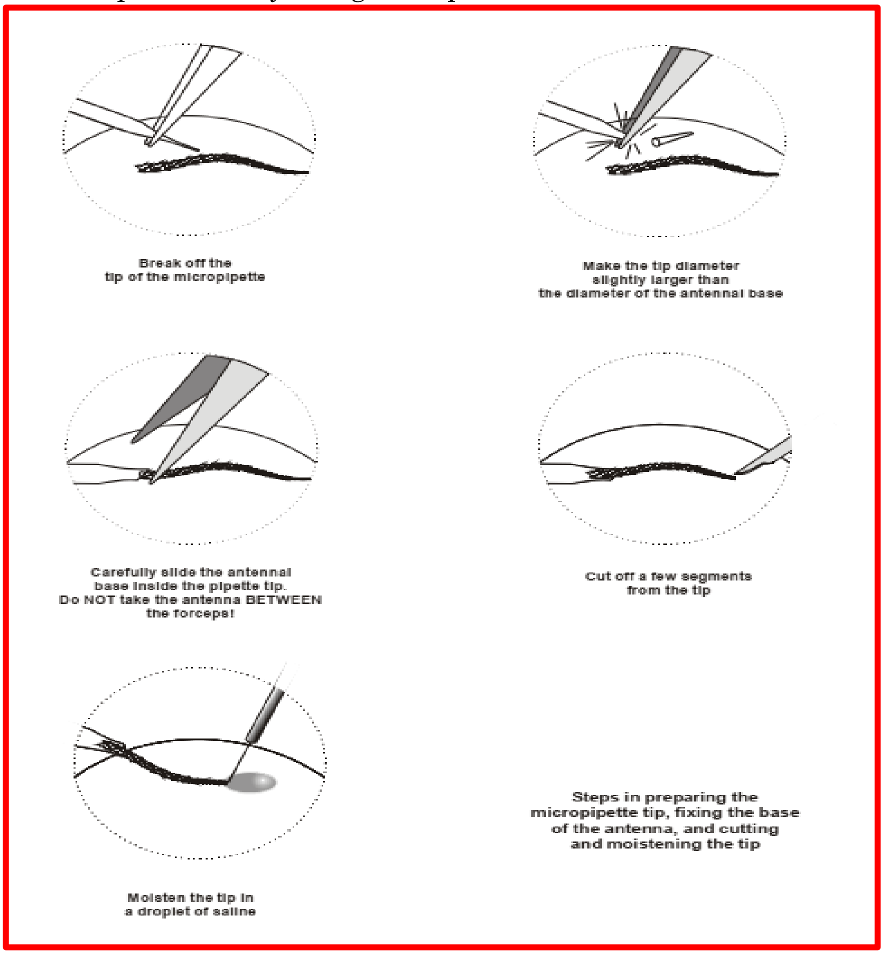


Image courtesy: Syntech, 2015

Basic components of an EAG setup include:
1. Prepare the antennas and use manipulators to record the electrodes.
2. Amplifier and signal processing electronics
3. Signal display and recording system
4. Stimulus application system.

Mounting the Antenna

There are numerous ways to attach the antenna between the tips of the micropipettes. For filiform (elongated, wire-shaped) antenna the most practical method is to insert the ends of the antenna into the tips of the micropipettes. The procedure is as follows:
1. Use a fine dissecting knife or a pair of microscissors to cut the antenna from the insect's head.
2. Place the antenna in the field of view of a medium power stereo micro- scope.
3. Bring the tip of the micropipette close to the antenna under the micros cope.
4. Break off the tip of the micropipette using a micro forceps.
5. While breaking the tip compare the size of the tip opening with the diameter of the base of the antenna and try to make the inner diameter of the micropipette to be slightly larger than the outer diameter of the antennal base.
6. Carefully slide the base of the antenna inside the tip of the micro pippete do not take the antenna between the tips of the forceps: this will certainly damage the antenna.
7. Clip off a few segments from the tip of the antenna.
8. Put a droplet of saline (with PVP) in the field of view.
9. Moisten the tip of the antenna by forcing it into the saline droplet using a fine dissecting needle. Contact with the recording electrode is substantially facilitated by moistening the antenna's tip.
10. Insert the pipette holding the antenna into the electrode holder.
11. Prepare the micropipette for the tip contact. This tip's size ought to be sufficient for inserting the antenna's cut end. If the pipette tip is broken at an angle, it is easier to insert the antenna tip.
12. Slide the manipulators carrying the electrodes for the micropipette nearer one another and place the antenna's tip towards the tip of the open micropipette.
13. Slip the tip of the antenna into the open tip of the recording micro pipette. A little help with a fine dissection needle or preparation hair may be required to guide the tip of the antenna.
14. inspect the micropipettes for absence of any air bubbles, which might have been developed during insertion of the antenna. Even small amount of air will disrupt the electrical circuit and prevent appropriate pre venting.

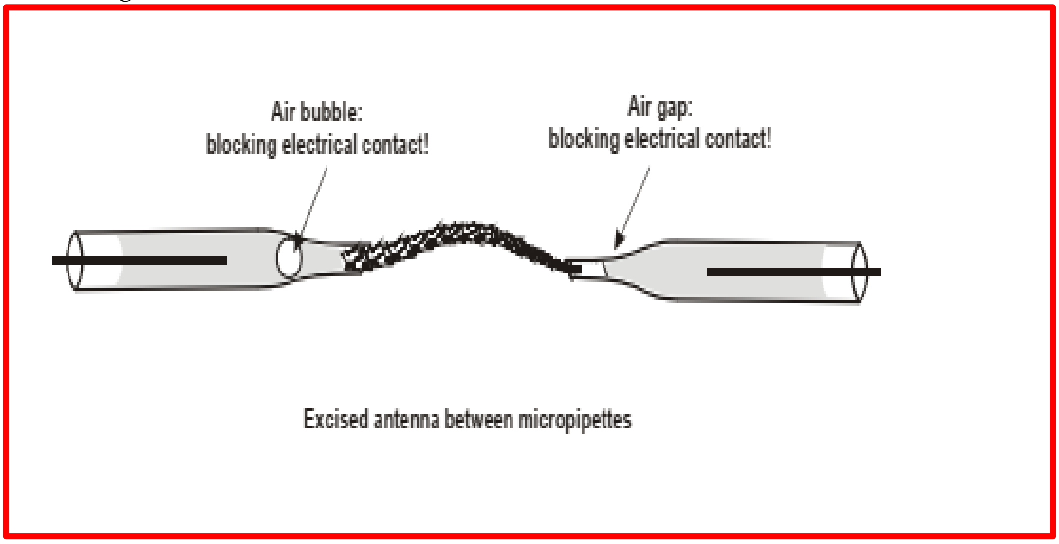


Image courtesy: Syntech, 2015

EAG Recording

Watch the recording device: a relative stable base line should be visible if the antenna makes good contact with the electrodes.

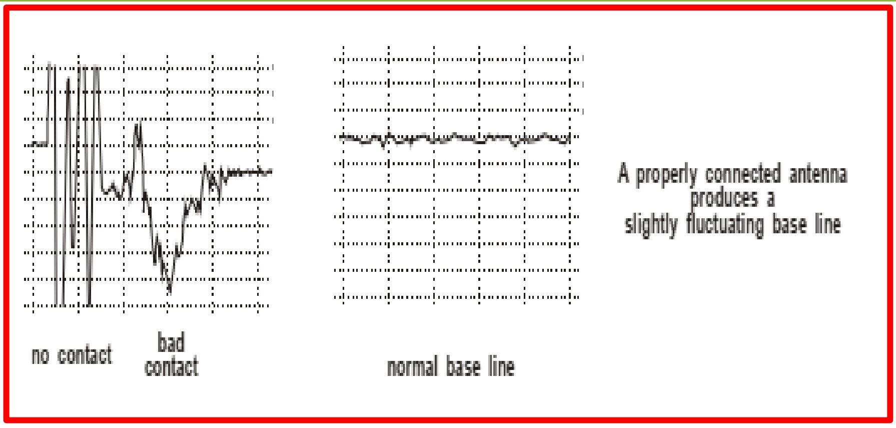
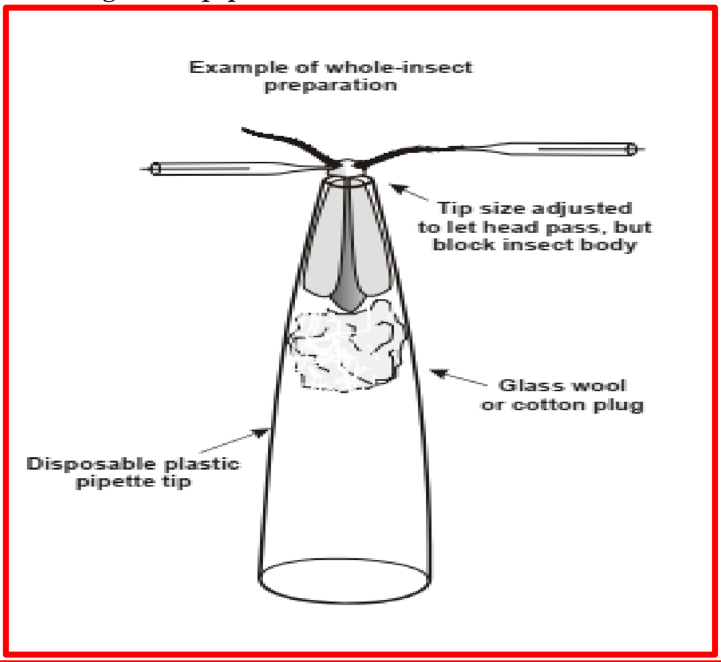


Image courtesy: Syntech, 2015

Depending on the morphology of the antenna this procedure may need to be adapted Very short club-shaped antenna, as found in flies and beetles, can hardly be excised from the head without causing serious damage to the antenna; In such cases the antenna is left on the head, but the head is excised and mounted on the micropipette tip; without removing any of the antenna tip's segments, the club of the antenna is pressed up against the end of the recording micropipette.



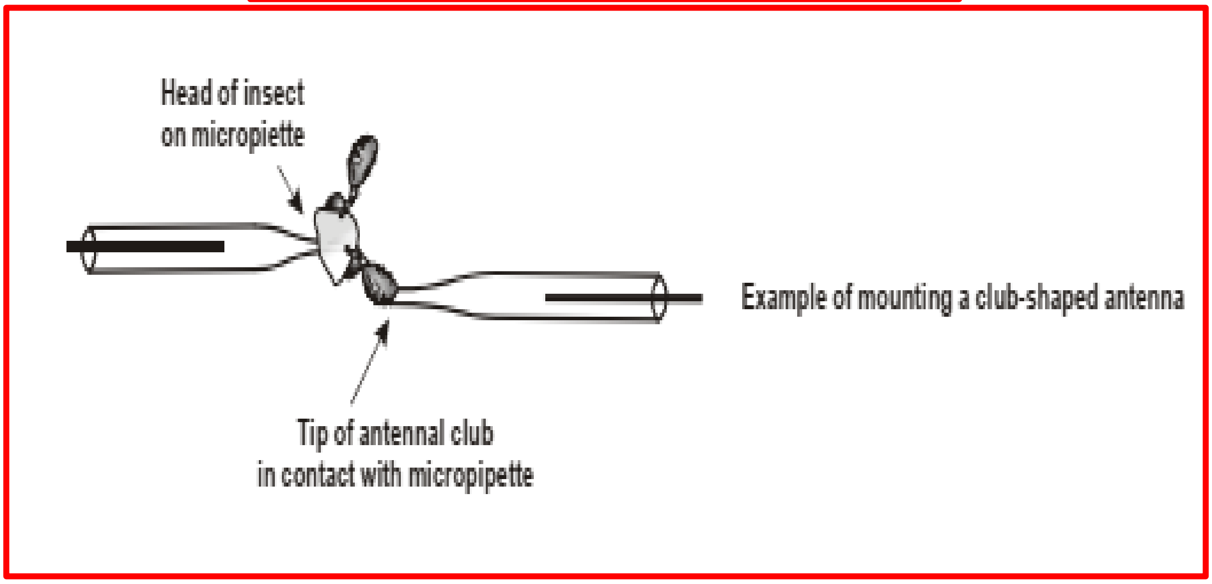


Image courtesy: Syntech, 2015

Good EAG recordings can be made by just contacting the open end of the recording micropipette to the end segment of the antenna. In such situations the size of the tip of the recording micropipette could be as large as the diameter of the end segment of the antenna. Before replacing a used antenna by a fresh one the micro pipettes need to be cleaned or replaced. It is advised to use new pipettes for each new antennal preparation if PVP is added to the saline.

Alternative Methods of Antenna Preparation

Whole Insect preparations: The life time of an excised antenna is limited - depending on many factors - from only few minutes up to one or two hours. If only a few insects are available, or if long duration recordings need to be made like in coupled gas chromatography-electroantennographic detection (GC-EAD) it might be advantageous to leave the antenna attached to the insect. There is no established technique for preparing intact insects. The insect needs to be immobilized before the recording micropipettes are brought into contact with respectively the base and the tip of the antenna. Plasticine and tiny copper wires can be used to fix the insect to a small platform. Another method is to fix the insect inside the tip of a disposable plastic pipette, the diameter of the tip of which has been adjusted to allow the head to protrude outside the tip while the body of the insect is caught inside the pipette body. In every complete insect preparation, one micropipette is placed close to the antenna's base and the other is put at the antenna's (cut off) tip. It is important to place the basal pipette close to the antennal base to avoid interference with electrically active structures, like antennal muscles. Electrically conductive gel A very attractive method of mounting an excised antenna is the use of an electrically conductive gel. The gel can be used in micropipettes to replace the KCL saline solution, or can be used applied onto a metal electrode surface into which the antennal ends are inserted. Unlike water-based saline (KCL) solution, which repels the hydrophobic antenna, the gel easily forms a contact with the antenna. The end of the antenna can be simply pushed into droplets of the gel, which are applied to the metal electrodes (silver or stainless steel). Practice has shown that a proper quality of gel (Spectra 360, Parker, Orange, N.J. USA) does not significantly interfere with the EAG responses, and that it can be used to great advantage for a large variety of preparations. A good quality gel does not dry out quickly, and preparations may last for more than an hour.

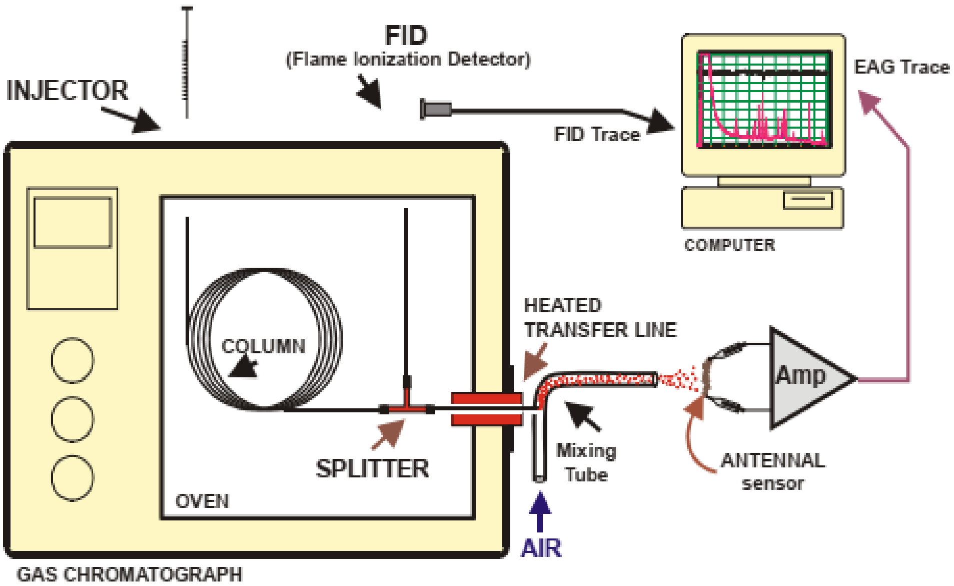
An insect perceives or detect the olfactory or volatile signal through olfactory sensilla mostly of which are situated on insect antennae. Schneider (1957) reported that when insect perceives volatile signal like pheromone there is small fluctuation in voltage between tip and base of the antennae and the fluctuation is due to electrical depolarization of olfactory neurons present in the antennae. This finding made the basis of electroantennography instrument. The basic components and use of this instrument have been reported (Syntech, 2015). The instrument essentially consists of electrodes (one recording and other as reference), amplifier, IDAC signal collection box, stimulus controller, stimulus mixing tube and source tube and software for recording electrograph in computer.

The response of insect can be recorded from cut antenna or head with antenna or from whole body preparation (Syntech, 2015). Upon exposing antenna to the volatile compound, an electrogram is generated if that compound is stimulating olfactory sensilla. The amplitude of the electrogram or peak depends on type of volatile compound, concentration of the stimulus (generally EAG response amplitude increases with increasing concentration of stimulus until saturation level), insect species, sex of the species, physiological maturity and mating status of the individual insect, time of recording (Nocturnal insects usually responds well during night recordings) etc. EAG recordings are mostly useful to screen large number of the extracts (insect or plant) to identify extracts which contains insect responsive components and to study the response eliciting behaviour of synthetic volatiles.

The insect gland or any other body part extracts or whole-body extract and plant extracts contains numerous volatile organic compounds. GC-EAD is used to distinguish or identify only those VOC's which are eliciting response from the insect antennae. The usefulness of this system was reported by Moorhouse *et al.* (1969). This instrument is a coupling of GC and EAG through an effluent conditioning assembly or heat transfer line. The typical organization of GC-EAD is reported by Syntech (2015). Eluent of the GC column is split into two parts by splitting the column with help of Y-connector. The one branch of the splitter leads eluted compound to GC detector and other part is sent to EAG antennal preparation through heated transfer line followed by filtered and humidified air.

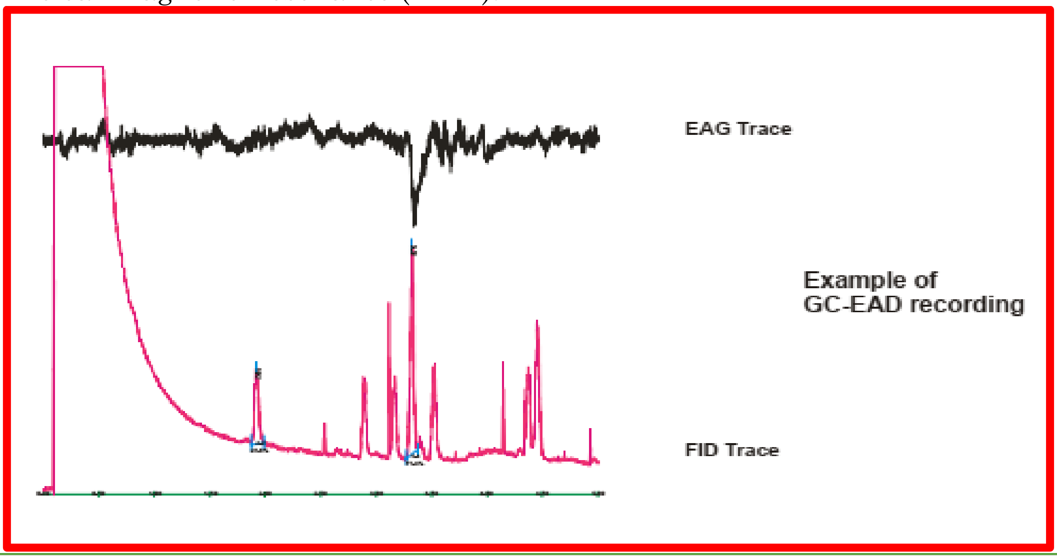
GC-EAD (Gas Chromatography Electroantennogram Detector)

Before final ploughing compost or farmyard manure @ 5 tonnes/acre (12.5 tonnes/ha) should be applied and ploughed into the soil. Instead of this cattle penning can also be practiced. 50 kg neem cake and 500 kg vermicompost per acre (125 kg neem cake and 1250 kg vermicompost per hectare) should be applied as basal manure. For rainfed crop, apply 50 kg/acre (125 kg/ hectare) of pungam cake and 250 kg/acre (600 kg/hectare) of vermicompost as basal manure just before sowing. After first weeding at 20 – 25 days after sowing top dressing should be done using enriched vermicompost (2 kg *Azospirillum*, 2 kg *Phosphobacterium* and 2 litres *Panchagavya* mixed with 250 kg vermicompost and kept covered for a week and then used) @ 250 kg/acre (600 kg/ha). During flower initiation stage 10% tender coconut solution (1 litre tender coconut water + 9 litres of water) should be sprayed. All the above-mentioned inputs should be applied to the rainfed crop only when the soil is wet.



Coupled gas chromatography - electroantennographic detection (GC-EAD)

Here as long as GC runs the antenna is continuously exposed to eluting compounds and compound peaks from GC detector and response of insect antenna to compound is simultaneously recorded. It is feasible to discern response-eliciting GC peaks because both peaks or signals are coordinated. However chemical identity of the compounds has to be done through techniques like gas chromatography-mass spectroscopy (GC-MS) and Nuclear Magnetic Resonance (NMR).



Conclusion

As EAG studies gives idea of insect response to various odorants, results may help us to manage insect pests by using insecticides having volatile properties and use of fumigants, sex pheromones in bringing down the pest populations in field as well as in storage conditions.

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Vermicomposting for Sustainable Agriculture

Article ID: 40730

H. H. Khan[1], A. K. Mishra[1], S. P. Singh[1], Amit Tomar[1], Prachi Patel[1], R. P. Singh[1]
[1]ICAR-Krishi Vigyan Kendra, Gajraula, Amroha, (Directorate of Extension), Sardar Patel University of Agriculture & Technology, Meerut, U.P.

Introduction

Modern agriculture based on chemicals is not sustainable because of many problems such as loss of soil productivity from excessive erosion and associated plant nutrient losses, surface and ground water pollution from pesticides, fertilizers and sediment, impending shortages of non-renewable resources, and low farm income from high production costs. As a result, there is increasing awareness of the need for alternative agricultural systems. Such a system should integrate traditional practices with modern understanding of life science. The concept of soil, as a living system, is central to alternative farming systems as opposed to chemical farming. It is essential to establish and maintain an active and abundant soil life in order to produce healthy plants. Therefore, the soil must be "fed" in a way, that the activities of beneficial soil organisms, necessary for recycling nutrients and producing humus, are not inhibited. Use of earthworms for degradation of organic wastes and production of vermicompost is becoming popular and is being commercialized. Darwin (1881) was the first to show that earthworms affect soil formation and development. His conclusion was a clear enunciation of the beneficial effects of earthworm on soil fertility. Thousands of farmers, in the different agro-climatic regions of India, are switching over to sustainable agriculture in field and horticultural crops, by adopting vermiculture biotechnology.

Vermiculture Biotechnology

Biotechnology essential involves a large-scale application of bio-systems for economic and effective processing of materials to produce value added. Vermiculture is culturing of earthworms. Vermiculture biotechnology is, therefore, an aspect of biotechnology involving the use of earthworms as versatile natural bioreactors for effective recycling of non-toxic organic wastes to the soil, resulting in soil improvement and sustainable agriculture. Earthworms are invertebrates assigned to phylum Annelida, class *Chaetopoda* and order Oligochaeta. Oligochaeta includes the major earthworms belonging to *Megascolecidae*, Lumbricidae and other families. More than half the earthworm species of the world belong to Megascolecidae. The genus Phretinia alone has a large number of species. Both Megascolecidae and Lumbricidae are valuable to agriculture and are, therefore, intimately linked to human welfare, development and progress.

The Commonly Used Species are

(i) Eiseniafretida, Perionyx excavates, Lumbrieusrubellus, L. terrestris, Eudrillus spp.
(ii) Lampitomauritii, Octochaetona serrate, DrawidaWillsi, O. surensis and O. thurstoni.

There are four varieties of earthworms available in India, which are called manure worms. These can be cultured on animal dung, poultry droppings and vegetable and others kinds of biodegradable wastes. The worm cast or excretions of worms form the needed organic fertilizer. One worm weighs about 0.5-0.6 g and consumes wastes of the same weight in a day. If one million worms exist in one acre the cast, they produce in that area is about 500 kg/day/acre i.e. about 200 tonnes per year. The worm cast contains all the nutrients in available form and in addition, a great deal of organic matter is provided to the soil which makes it very productive.

Earthworms play a key role in soil biology as versatile natural bioreactors. They effectively harness the beneficial soil microflora, destroy soil pathogens and convert organic wastes into valuable products such as biofertilizers, vitamins, enzymes, antibiotics, growth hormones and proteinous worm biomass. Hence, we can call the earthworms as **"artificial fertilizer factories"**.

1. Earthworm's gut is an effective tubular bioreactor with raw materials (feed) entering from one end and the product (castings) coming out through the other end.

2. They maintain a stable temperature through novel temperature regulation mechanisms, thus accelerating the rates of bioprocesses and preventing enzyme inactivation caused by high temperatures.
3. Gizzard is a novel colloidal mill in which the feed is ground into particles smaller than 2 microns, giving thereby an enhanced surface area for microbial processing.
4. They have an in-house supply of enzymes such as protease, lipase, amylase, cellulose and chitinase, which bio-degrade complex biomolecules into simple compounds utilizable by the symbiotic gut microflora.
5. Earthworms have a built-in oxygen plant which can separate aerial oxygen by chemical absorption into blood haemoglobin.
6. They promote growth of microorganisms in their gut by providing favourable conditions.

Castings contain nutrients in a balanced proportion and are rich in vitamins, enzymes, antibiotics and growth hormones.

Earthworm for Nutrient Management

Effect on soil fertility: Earthworms modify soil physical, chemical and biological properties and it is believed that they enhance nutrient cycling by ingestion of soil and humus and by production of casts. There is abundants evidence to show that concentrations of exchangeable Ca, Na, Mg, K and available P and Mo are higher in earthworm casts than in the surrounding soil. Also, they have a higher base exchange capacity (Table-1).

Table-1: Comparison of the available mineral elements in the cast of earthworms and in the upper layer of ploughed soil.

Particulars	Earthworm Cast	Depth of soil layer	
		0-15 cm	20-40 cm
Loss on ignition (%)	13.1	9.8	4.9
C : N ratio	14.7	13.8	13.8
NO3- Nitrogen (ppm)	21.9	4.7	1.7
Available P (ppm)	130.0	20.8	8.3
Available K (ppm)	335.0	32.0	27.0
Exchangeable Ca (ppm)	2.78	1.99	1.81
Total Ca (%)	1.19	0.88	0.81
Total Mg (%)	0.545	0.511	0.548
Exchangeable Mg (ppm)	49.2	162	69
pH	7.0	6.36	6.05

Soil enrichment is achieved by speeding up mineralization of organic matter 2 to 5 times. Earthworms greatly increase the amount of soluble and available N, P and K.

Nitrogen

Increased availability of N in earthworm casts compared to that in the non-digested soil has been attributed to the higher microbial population and enzyme activities in the casts. Some workers have suggested that earthworm mortality is the probable source of the increase in plant available soil N-pool. However, the contribution of N from this source was relatively small (3-4 per cent) enriched in N compared to surface horizon. Intimate mixing of plant remains and animal manure with mineral soil also adds to the higher nitrogen content of the casts. An increase in the rate of nitrification in casts relative to the associated soil brings out the potential importance of earthworm in N in fresh casts is present as NH_4^+ N and rapid nitrification occurs following cast deposition. Moreover, a portion of the non-plant available N (6 per cent) ingested by Allolobophoracaliquinosa is excreted in forms readily available to plants.

Phosphorus

Earthworms casts are enriched in water soluble P in comparison to the underlying soil. The plant availability of P in super phosphate (SP) and a phosphate rock (PR) as influenced by earthworms was evaluated in a glass house experiment using perennial rye grass over seven harvests. Increases in the yield of rye grass in the presence of earthworms varied from 2-32 per cent, whereas increase in P uptake ranged from 0-40 per cent over 7 harvests with SP, the initial increase in both rye grass yield and P uptake in presence of earthworm ranged from 20-40 per cent at first harvest to less than 10 per cent by the seventh.

In marked contrast, earthworms increased the agronomic performance of pelletized rock phosphate by 15-30 per cent throughout the period. An increase in plant available soil N concentrations due to earthworm activity probably explains the initial difference in performance of super phosphate.

The increased agronomic effectiveness of rock phosphate appears to result from the incorporation and intimate mixing of the phosphate rock with the soil by earthworms. It is not clear, however, whether the earthworms directly incorporated RP particles into the soil at lower depths, through their feeding and burrowing activity or the presence of burrows open to the surface of burrows open to the surface simply facilitated the downward movement of surface-applied phosphate rock particles during watering.

In addition to the incorporation effect of the earthworm, ingestion of phosphate rock particles during feeding, could lead to an increase in the intimate mixing with soil. Apart from these effects, a biological mechanism, mainly increased microbial activity also occurs. Thus, in the absence of biological mixing, both the form and method of application of phosphate rock materials become an important consideration in evaluating their efficiency. In addition, when earthworms are excluded, the form and method of application of rock phosphate become important in the inter-pretation and extrapolation of glass house experiment results to the field situation.

Potassium

The casts of earthworms contains 2-3 times more available K than the surrounding soil. Under controlled conditions, the availability of K is enhanced significantly following soil ingestion by earthworm by works must be due, atleast in part, to the changes in the distribution of K between exchangeable and non-exchangeable K forms due to gut processes (Basker *et al.*, 1992).

Fig.-1: Vermicompost production techniques

Earthworms for Water Management

Earthworms, numbering 0.2-0.5 million/ha, make permanent structurally stable burrows, numbering 0.5-1.0 million per ha, allow water infiltration upto 120 mm per ha. Hence, in spite of heavy spell of rain, there is hardly any runoff and soil erosion, as each burrow acts as a microdam. Earthworms affect the pore space in soils by burrowing and by depositing their casts as loosely packed aggregates on the soil surface (Vanrhee, 1977). For example, in soils of Dutch orchards lacking earthworms, pore space is determined by the packing of mineral particles and that about 30-40 per cent of the total soil volume consisted of fir filled or water filled spaces (Carter et al., 1982). Similar soils with earthworms (biomass as high as 200 g/m^2) has a total of 60-70 per cent pore space; about 40 per cent water filled and 22-30 per cent air filled. At a depth of 25 cm in orchard soils with high earthworm populations, there are 200 earth worms burrows/m^2 of surface area and most of the air filled spaces in soils of good moisture holding capacity are earthworm burrows. From this we can say that increase of 75-100 per cent in pore space is mainly due to earthworm. Two third of the air-filled pore space in soils may be earthworm burrows. The burrows must be regarded as an additional drainage system, a very significant one, within the soil matrix that operates during periods of heavy rain or when soils are irrigated. However, in a permanent pasture with a relatively low population of lumricides, the recognizable earthworm burrows are too wide to conduct water at tensions normal during infiltration and the earthworms have little significance in promoting water movement through soils under Mediterranean climatic regions. The total and available moisture content at field capacity and available moisture content for 0-30 cm depth is 17 per cent higher in pasture with lumbricide than in the pasture without lumbricides and macro-porosity decreases markedly from 44.9 to 21.5 per cent at 0-10 cm and from 29.3 to 22.7 per cent over 0-30 cm depth. There was an accompanying increase in bulk density from 0.68 to 0.86 g/cm^2 at 0-10 cm but with no change over 0-30 cm depth where lumbricide has been introduced compared with soils that lacked lumbricieds. These changes are mainly due to the observed degradation and incorporation of porous pasture roots by water is supplied in large quantities, is also greatly affected by earthworms.

Earthworm Castings

The castings of earthworm are stable. Earthworms excrete granular, structurally stable casting on the soil surface. These do not disintegrate into micro particles when dry or wet and hence, there is no soil loss due to wind or water. The runoff water, if any, is clear. The activity of earthworms is recognized as beneficial for the improvement of soil physical conditions and plant growth. Also the coarse sand fraction is reduced in casting by selective ingestion by worms. On the one hand this is because of the burrowing activities of earthworms which improve air and water penetration into soil and on the other hand it is because of the earthworm casting which stabilize soil aggregates. Blanchart *et al.* (1990) assessed the effect of tropical geophagous earthworm, Millsoniaanomala, on particle aggregation in a tropical soil in the presence of

Panicum maximum and concluded that in the presence of Millsoniaanomala, there was substantially increased aggregation. In the absence of earthworms, a rapid aggregation of soil particles occurred, through the activity of microorganisms, and physical mechanisms although this did not increase consistently across subsequent sampling times. Earthworms do not ingest their own casts and aggregation rapidly increases to a maximum value of 60 per cent when populations are high, and then the earthworm activity declines.

Earthworms Act as Bio-Pump

Earthworms burrow enhances water infiltration and storage over a considerable depth of soil. Earthworms help to bring this moisture to the upper layer by acting as biopump. They produce biological water during the decomposition of organic matter. This "slow release" water can be effectively utilized by the roots.

Earthworms for Effective Waste Management

Vermiculture biotechnology is being harnessed to set up units for cost-effective treatment of various non-toxic organic solid and liquid wastes from the cities, dairies, sugar and distillery units, pulp and paper mills, tanneries, fermentation industries and food processing units. Apart from environmental protection through pollution abatement, these environmental protection through pollution abatement, these units can serve as production centres of vermicastings because of beneficial microflora and worm cocoons associated with them. Soils with a good population of earthworms could be used to handle various non-toxic organic wastes. Earthworms maintain aerobic conditions in the soil and effect complete waste stablisation with beneficial soil microflora, which release the plant nutrients and produce valuable products such as vitamins, antibiotics and growth hormones. Pathogens are also destroyed. Sabine (1983) has summarized the potential benefits of large-scale intensive culture of earthworms on organic wastes as follows:

1. Reduction of noxious qualities of wide variety of organic wastes such as, elimination of smell, reduction of harmful microbes and ease in physical handling.
2. Production of useful and marketable organic fertilizer, compost or potting media from organic wastes. Protein production for stock feed, or human food from organic wastes.

Composting of Municipal and Industrial Wastes

Hartenstein (1978) described laboratory trials of vermicomposting of aerobic sludge from waste water (sewage) treatment plants with Eiseniafretida in the compost. He compared the end-products, compriosing worm casts, that have value as a fertilizer and potting soil and earthworm which are high in protein. The latter could be sold as a protein additive for animal feed. The methods of biodegradation comprise:

1. Composting with microorganisms, resulting in a material that can be used as a soil amendment but has little value as a fertilizer.
2. Incineration which is environmentally undesirable, energy demanding and leaves a virtually unusable residue, and,
3. Burial which is energy demanding, expensive and can result in pollution of water supplies/bodies.

Earthworms for Diseases and Pest Management

Healthy soil has a balanced population of beneficial and soil microflora and burrowing earthworms. This reduces the population of soil pathogens, through competition and antibiosis. Almost all insect and pathogenic attacks are targeted to the nutritionally weaker plants. Earthworms produce casts which provide balanced nutrition to plants, thus giving them tolerance to pest attack. Interactions between earthworm, soil microorganisms, and root pathogens have been studied very little.

Earthworms for Nutritional Crops

Increase in crop yields and quality has often been recorded in plants grown in the presence of earthworm casts. Considerable scientific data have been generated to show that organic produce is nutritionally superior, tastes good, has good luster and better keeping qualities. Crops grown organically, with slower growth rates and greater physiological maturity harvest, have been shown, in carefully controlled trials, to have longer storage life. The influence of earthworms' casts on N metabolism has been indirectly made evident by an increased protein content in young oat plants, barley, rye, wheat and in mushrooms. The earthworms' casts could stimulate the activity of nitrate reductase enzymes. It is logical to conclude that the increase in protein content depends on improved protein synthesis although the mechanism involved is still unclear. But it is evident that microbes and microbial metabolites are involved. In protein synthesis, microbial hormone like substances could play an important role by regulating ionic absorption and including some enzymatic activities. When used as a component of a casting layer in Agaricusbisporous cultivation, earthworm casts stimulated primordial formation and initiation and enhance the protein content of the carpophore. Microbial metabolites could be responsible for this effect, since they affect fratification of Agaricus.

Earthworms for Sustainable Agriculture and Wasteland Development

Vermicastings produced through the burrowing earthworms are being used by many farmers to change from chemical to sustainable organic agriculture without loss of yields. Eroded as well as saline soils are being developed through vermiculture biotechnology with noticeable results within a year. The package, particularly suitable for crops such as fruits, vegetables, sugarcane, cotton, etc., where a surface layer of organic mulch can be practically maintained, consists of:

1. Applying a first layer of vermicasting @ 5t/ha.
2. Watering once in every 15-20 days and
3. Periodic application of dung and mulches

Worms hatch out from cocoons in vermicastings within a month. They start processing the dung and organic mulch and produce vermicastings making the system almost a zero external input sustainable agriculture. A transition from chemical to sustainable organic agriculture takes 3 to 6 years. This is the time required to trigger without excessive reliance on chemical fertilizers and pesticides. This swift change over to sustainable organic agriculture without loss of yield is possible by seeding the soil with vermicastings. This will result in establishing a population of burrowing-type earthworms, about 0.2-1.0 million/ha. In 3 months.

Earthworms as Vectors of Beneficial Microorganisms

One of the major constraints for effective root colonization by beneficial soil bacteria is their limited capacity for unaided dispersal though soil. A variety of methods have been used to inoculate beneficial microorganisms into soil. But these procedures, when used in the field, commonly inoculate only a small portion of soil volume which is available to plant roots. The activity of earthworms has been shows to promote the dispersal through the soil a variety of types of beneficial soil microorganisms including Pseudomonas, Rhizobia and Mycorrhizal fungi. Reports indicate that earthworms are capable of acting as vector of Rhizobium trifolii. The presence of L. terrestris was associated with improved distribution of nodules on the root systems of soybean and this resulted from worm dispersal of Bradyrhizobiumjaponicum. The inoculation of highly effective rhizobia into legume seeds does not have always result in the formation of effective nodules and a corresponding high level of N-fixation because seed inoculation tends to result in localization of high cell densities in the vicinity as seed and emerging roots, with considerably lower numbers further away.

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Strawberry and its Benefits

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Y. D. Haritha[1]
[1]Ph.D Research Scholar, College of Community Science, Human Development and Family Studies, Acharya N.G. Ranga Agricultural University, Guntur, Andhra Pradesh.

Introduction

Strawberries are a favorite summer fruit. They appear in everything from yogurt to desserts and salads. Strawberries are a low-glycemic fruit, making them a tasty option for people looking to control or reduce their **glucose levels**.

Benefits

The vitamins, minerals, and antioxidants in strawberries can provide important health benefits. For example, strawberries are rich in vitamin C and **polyphenols**, which are antioxidant compounds that may help to prevent the development of some diseases. In addition, strawberries can provide other health benefits related to:

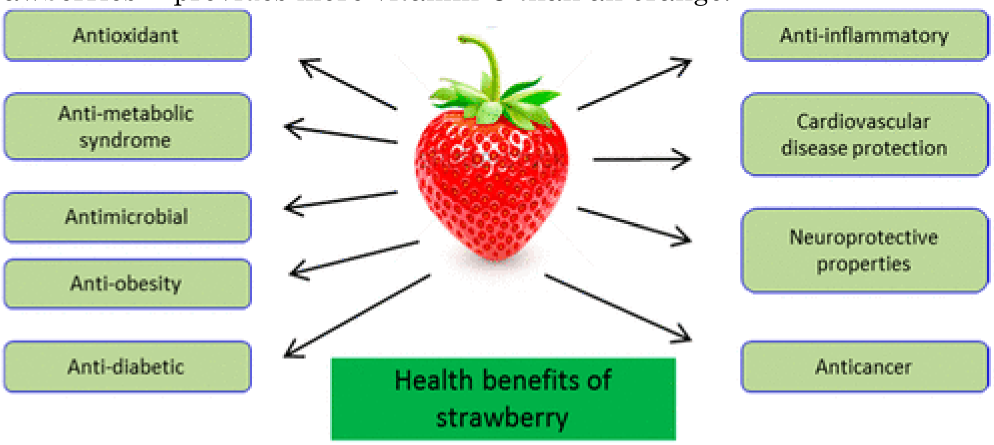
Insulin sensitivity: The polyphenols in strawberries have been shown to improve insulin sensitivity in non-diabetic adults. Not only are strawberries low in sugar themselves, but they may also help individual metabolize other forms of glucose.

Skin protection: Strawberries have anti-inflammatory effects that may prevent skin damage when applied topically. In one small study, strawberry-based cosmetic treatments protected skin exposed to harmful ultraviolet A (UVA)-radiation, especially in combination with coenzyme Q10.

Osteoarthritis management: One small study showed the anti-inflammatory benefits of strawberries can also protect other parts of the body, including the joints. For people with osteoarthritis and knee pain, strawberries can help reduce pain and swelling and improve quality of life. In one study, adults who ate 50 grams of strawberries each day for 24 weeks experienced an overall reduction in pain and inflammation.

Conclusion

Strawberries are good for your whole body. They naturally deliver vitamins, fiber, and particularly high levels of antioxidants known as polyphenols -- without any sodium, fat, or cholesterol. They are among the top 20 fruits in antioxidant capacity and are a good source of manganese and potassium. Just one serving -- about eight strawberries -- provides more vitamin C than an orange.



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Cultivation of Dragon Fruit

Article ID: 40732

B. Pawan Kumar[1], D. Naga Harshitha[1]
[1]College of horticulture, Rajendranagar, Sri Konda Laxman Telangana State Horticultural University, Hyderabad-500030.

Introduction

Dragon fruit a recently introduced super fruit in India, is considered to be a promising, remunerative fruit crop. Fruit has attractive colour and black colour edible seeds which is originated in Mexico and Central and South America ((Britton and Rose, 1963; Morton, 1987 and Mizrahi *et al*., 1997). It is a long day plant with beautiful night blooming flower that is nicknamed as "Noble Woman" or "Queen of the Night". It has ornamental value due to the beauty of their large flowers (25 cm) that bloom at night; they are creamy white in color. It is considered as a fruit crop for future (Gunasena and pushpakumara, 2006 and Gunasena *et al*., 2006). The biggest advantage of this crop is that once planted, it will grow for about 20 years, and 1 hectare could accommodate about 800 dragon fruit plant. It is being grown commercially in Israel, Vietnam, Taiwan, Nicaragua, Australia and the United States (Merten, 2003). It produces fruit in the second year after planting and attain in full production within five years.

Origin and Distribution

Most *Hylocereus* species originate principally is originated in Mexico and Central and South America (Mizrahi *et al*., 1997 and Daubresse Balayer, 1999). Today *Hylocereus* sp. are distributed all over the world (in tropical and subtropical regions) but H. *undatus* is the most cosmopolitan species in India followed by H. *costaricensis*. Because of the hardy nature of this fruit crop, it can survive adverse climatic conditions of arid and semi-arid region of India.

Morphology

Dragon fruit belongs to the botanical family Cactaceae and genus *Hylocereus*. This genus is mainly characterized by climbing vine cactus which reaches up to 1.5 to 2.5 meters with aerial roots that bear a glabrous attractive berry with large scales. It is a terrestrial or epiphytic cactus with succulent three-winged and green stems. *Hylocereus* spp. are diploid (2n = 22). Cactaceae are mainly appreciated for their ornamental qualities. Aerial roots of the plant absorb water and grow on the underside of stems and keep the stems on vertical surfaces. Dragon flowers are usually white in color and fruits are 25 to 30 cm long and 15-17 cm wide with bell-shaped (Merten, 2003).

Generally, three types of Dragon fruits are cultivated in different countries. All are leathery and slightly leafy skin. These are *Hylocereus ubdatus* (red-skinned fruit with white flesh), *Hylocereus costaricensis* (red-skinned fruit with red flesh) and *Hylocereus megalanthus* (yellow-skinned fruit with white flesh) (Hunt, 2006; Hamidah *et al.,* 2017).

Vegetative and Reproductive Biology of Red and White Pitaya

The flowers of these two species appear from the uplifting of areoles; they are large (more or less 30 cm) in the shape of a funnel and nocturnal. The ovary is located at the base of a long tube carrying the foliaceous scales to the exterior is 3 cm in length. There are numerous stamens on a slender anther stalk. The unusually large, tubular style is 20 cm in length and 0.5 cm in diameter the stigmas have 21 slender lobes, creamy green in colour (Daubresse Balayer, 1999; Luders, 1999). Floral growth does not depend on water availability, but on day length. The floral buds can remain in the latent stage for many weeks (Daubresse Balayer, 1999) and the beginning of flowering generally occurs after the rainy season. The number of flowering episodes or flushes depends on the species: seven to eight for H. *costaricensis* and five to six for H. *undatus*. There is a period of 3 to 4 weeks between flowering flushes (Barbeau, 1990) which makes it possible to see floral buds, flowers, young fruits and mature fruits on the same plant at the same time. Pollen is abundant and heavy and flower opens between 20:00 and 20:30 a.m. The non-fertilized falls off after 4 to 6 days and the fertilized flower remains green in color.

Cultivation Technique of Dragon Fruit

In India it was first successfully grown in Gujarat state. Dragon fruit is mostly propagated by cuttings it can also be cultivated by seeds. H. *undatus* and H. *costaricensis* can be multiplied naturally and very easily by cutting off the stem as soon as it touches the ground. The hardiness of the crop enables it to thrive under various field conditions provided cuttings are at least 50 to 70 cm and are regularly watered. A vertical support a 2–3 m distance between planting lines is required which could accommodate 2000 and 3750 cuttings/ ha, at the rate of three cuttings per support is planted (Barbeau, 1990). With horizontal or inclined supports the density can be much higher since the cuttings are planted every 50–75 cm around the production table (6500 cuttings ·ha–1) or along the inclined support (6500 cuttings–1). Planting at a distance of 2.5 m each to row and between the plants with 4 cutting/ support can accommodate 6400 plants / ha and also gives good yields and quality of fruits. The height of these different types of support should be between (1.40 and 1.60) m for vertical supports and between (1 and 1.20) m for horizontal and inclined supports to facilitate management of the crop.

Mineral Nutrition and Irrigation Requirement

Dragon fruit root system is superficial and can assimilate smallest amount of nutrients applied. Mineral as well as organic nutrition is advantageous both singly or in combination. It performs best when applied in four split doses @ N:P: K = 450:350:300.

Dragon fruit can survive with very low rainfall, many months of drought, when good quality fruits needed regular water supply is needed. Regular and micro irrigation ensure good development of fruits. Micro-irrigation avoids uneven and excess watering that can result in the flowers and the young fruits falling off (Barbeau, 1990).

Pollination

Manual pollination is desirable due to absence of pollinating agents to ensure good fruit set and development (Weiss, et. al., 1994 and Castillo et. al., 2003). Manual pollination is desirable due to huge floral parts. It can be carried out from 4:30 until 11:00 a.m. Pollination is accomplished by opening the flower by pinching the bulging part. This reveals the stigmata, which are then covered with pollen with a brush. Alternatively, the anthers can be directly deposited (with minimal pressure) on the stigmata with the fingers. The pollen can be removed from a flower of a different clone (or from another species) and stored in a box until needed. The pollen removed from two flowers will be enough for around 100 pollinations with a brush. It can be stored for from (3 to 9) months at –18 °C to – 196 °C without risk. Fruits obtained after pollination using pollen stored at 4 °C for (3 to 9) months are very small (Metz, et. al., 2000). However, the quality of the fruits resulting from free pollination is generally lower than that of those obtained by manual cross-pollination.

Harvesting

The fruit skin colors very late in the maturation stage, changing from green to red or rosy-pink (25 or 27) days (depending on the species) after anthesis (Nerd, *et al*., 1999). It will take 30 days for harvest to H. *costaricensis*. Four or five days later, the fruits reach their maximal colouration and leads to splitting and cause economical loss. The yield depends on planting density and is around (10 to 30) t/ha (Barbeau, 1990). The absence of a peduncle makes picking difficult. The present harvesting technique of simply move the fruit in clock wise direction and twisting the fruit cause less or no injury to the fruits.

Pests and Diseases

Ants belonging to the genera Atta (Barbeau, 1990) and Solenopsis are very notorious pest and can cause major damage to the plants as well as to the flowers and fruits. *Cotinus mutabilis* perforates the stem and *Leptoglossus zonatus* sucks the sap, leaving stains and some deformation (Barbeau, 1990). Different species of aphids and scales have also been observed on fruits and flowers. Rats and birds can cause serious damage, mainly to flowers and fruits as well as ripe fruits.

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Propagation Methods in Bael

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B. Pawan Kumar[1], D. Naga Harshitha[1]

[1]College of horticulture, Rajendranagar, Sri Konda Laxman Telangana State Horticultural University, Hyderabad-500030.

Bael (*Aegle marmelos* Correa) is an underutilized fruit indigenous to India. It belongs to the citrus family Rutaceae, and it is also known as Bengal quince. Its medicinal properties have been described in the ancient treatise like Charaka Samhita, Upvana Vinod and Yajur Veda, and it has also been portrayed in the paintings of Ajanta Caves.

Bael is usually propagated by seeds. The seeds are recalcitrant and cannot be stored for longer periods under normal storage conditions. Budding, patch or shield on seedling rootstocks in June or July gives very good success. Air layering is also successful under humid tropical conditions. In vitro propagation has also been standardized but it is not feasible commercially.

Seeds germinate in 8-15 days after sowing during summer under rainfed semi-arid conditions (Singh *et al.* 2011a) Sometimes seeds germinate while fruits are kept on tree for longer duration after ripening of tree (vivipary) (Singh *et al.* 2018).

Patch budding is the commercial method of multiplication of bael (Singh *et al.* 2014a). This method is very useful for transportation of sapling to the distant places (Singh *et al.* 2018a). Patch budding and softwood grafting were found to be successful when performed in the month of May-June.Under arid conditions of Bikaner, Rajasthan; more than 90% success was obtained through patch budding on polybag raised rootstocks in July (Saroj *et al.* 2006).

Vegetative Propagation

Patch Budding: Rectangle incision is made on the rootstock by placing the bud on the rootstocks to mark the exact size of the bud on them and after removing the bark of the rootstock and tying with white polythene strip (200-gauge thickness and 2 cm wide). The rootstock is cut about 10 cm above the bud to facilitate bud sprouting. The time of budding influences the survival of plant in different varieties. Singh *et al.* (1976) reported 100 % bud take during the month of June or July. Effect of scion genotypes on patch budding in bael has been reported by Mishra and Jaiswal (2001).

In Situ Patch Budding: In arid and semiarid regions, in situ budding is the most successful method for establishing a bael orchard. This is done by sowing 2–3 seeds directly in the field or by planting seedlings. After 1 year, budding is done in the field. In bael, the tap root system is very vigorous and if disturbed during the process of planting of grafts, it ultimately affects growth and establishment adversely in the field conditions.

Softwood Grafting: Shoots of 3–4 months old are defoliated 10–12 days prior to grafting operation. For this, seedling rootstock is cut at 10–15 cm height. With the help of a knife, a 5 cm long vertical downward incision is made in the center of the rootstock. A sharp cut of 5 cm is made on both sides on the base of the scion shoot to make wedge shape, and the graft is tightly secured using a 200-gauge thick and 2 cm wide polythene strip.

In Situ Softwood Grafting: The desi rootstock is raised at desired spacing directly in the field; the seeds should be sown directly in the field during rainy season under rainfed condition. In situ softwood grafting through wedge method is done in the months of June–July on a 1-year-old seedling. The bud sprouts within 15–20 days of grafting and polythene strips are removed after the union. The plants are given support with the help of stakes to protect them from stormy winds. High temperature and relative humidity during June–July have helped in early sprouting and better graft success, because of fast establishment of vascular connection with rootstock.

Root and stem Cuttings: Bael can be propagated successfully by root cutting during monsoon.To ensure establishment, suckers are planted in nursery beds for about 2 years after uprooting and are then shifted to the main field. Ray and Chatterjee (1996) reported that growth regulator and etiolation treatments were significantly effective in inducing roots in ringed stem cuttings of A. *marmelos*.

Layering: Air layering is very successful in bael provided that mother trees are given invigoration treatment by heading back to few of the thick branches during April. Air layers are prepared in the second week of August by bark ringing and application of IBA at 10,000 ppm in lanolin paste.

Micropropagation: True-to-type and disease-free plants can be generated from a very small piece of plant in aseptic condition in artificial growing medium rapidly throughout the year. Regeneration can be done from explant nucellus (Hossain *et al*. 1993) and cotyledons leaf (Islam *et al*. 1993).

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Technological Trends in Digital Agriculture

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Dr. N.V. Gowtham Deekshithulu[1], Dr. B. Krishna Kanth[2]
[1]Horticultural Research Station, Dr. YSRHU, Venkataramannagudem, West Godavari.
[2]Aditya Engineering College, Department of Agricultural Engineering, Surampalem.

Abstract

Market forecasts for the next decade suggest a 'digital agricultural revolution' will be the newest shift which could meets the agriculture needs of the global population into the future. Technological advancements in the agriculture sector meet the growing demand for farm automation, digitalization, and sustainability. Emerging agriculture trends mark a shift towards smart farming and efficient utilization of time and resources while reducing crop losses. Smart farming is an upcoming concept that deploys technologies like the Internet of Things (IoT), computer vision, and artificial intelligence (AI) for farming. Robots and drones are accelerating farm automation by replacing manual farm operations such as picking fruits, removal of weeds, irrigation or water spraying. Imagery from drones and satellites, coupled with Global Positioning System (GPS), provides a high-resolution and location-specific view of the field. Further, IoT devices, powered by sensor technology, collect real-time field data that allow farmers to make data-driven decisions. In addition, the widespread adoption of precision agriculture and indoor farming in recent years fuels IoT growth in farming. Taken together, these technological innovations generate disruptive and sustainable changes in agricultural practices. The focus is to not only improve the overall quality and quantity of crops and enhance livestock management but also to reach the ultimate goal of a sustainable future.

Introduction

In the context of the Sustainable Development Goals, digital agriculture has the potential to deliver economic benefits through increased agricultural productivity, cost efficiency and market opportunities, social and cultural benefits through increased communication and inclusivity and environmental benefits through optimized resource use as well as adaptation to climate change.

Trends to Look Out in Agriculture

1. Internet of Things: Monitoring of the crop field in conventional farming requires intensive labour, physical equipment, time, and effort. IoT provides an alternative to these traditional methods. An IoT device contains one or more sensors that collect data and provide accurate information via mobile applications or other means in real-time. These sensors perform countless activities such as soil temperature and humidity sensing, plant and livestock tracking, and more. IoT also facilitates remote monitoring of farms, providing greater convenience to farmers. Further, new irrigation systems utilize IoT sensors to automate water delivery to crops. These constitute evapotranspiration sensors, on-site soil moisture sensors, and rain sensors, among others. Start-ps are developing innovative sensor solutions that combine IoT technology with drones, robots, and computer imaging to increase the agility, accuracy, and precision of farming processes. These send on-time alerts and improve the response time for areas that need attention.

2. Agricultural Robotics: Shortage of labour is a critical problem for farmers, and this is amplified in the case of large field operations. So, start-ups are manufacturing agricultural robots to assist farmers in fruit-picking, harvesting, planting, transplanting, spraying, seeding, and weeding. Farmers are increasingly relying on robots to automate repetitive tasks in the field. They deploy smart agricultural machines, such as autonomous and semi-autonomous tractors for harvesting. Tractors also come with auto-steer technology for easier navigation across the field. Moreover, robots are used in automated systems for livestock management as well. This includes automated weighing scales, incubators, milking machines, and auto feeders. Robots allow farmers to focus more on improving overall productivity, without having to worry about slow farm processes. They also prevent human-induced errors and provide convenience through automation.

3. Artificial Intelligence: Incorporating AI in agriculture provides farmers with real-time insights into their field conditions, allowing them to be proactive. AI offers predictive insights for forecasting weather data, crop yield, and prices, thereby aiding farmers to make informed decisions. Chatbots offer suggestions and input recommendations to farmers. AI and ML algorithms automate anomaly and disease recognition in plants and livestock. This enables timely detection and corrective response if required. Biotechnology also deploys ML algorithms for gene selection recommendations. Further, AI provides easy access to finance to farmers who are denied credit from banks through alternative credit scoring. Start-ups are exploiting AI in several ways to come up with innovative solutions that improve overall agricultural quality. For example, harvest quality vision (HQV) is a recent AgriTech innovation that scans and determines the quality and quantity of fruits and vegetables.

4. Drones: Increasing farm productivity while saving costs is challenging. But drones, also known as unmanned aerial vehicles (UAVs), help farmers overcome this hassle in an effective way. Drones collect raw data which translates into useful information for farm monitoring. Drones equipped with cameras facilitate aerial imaging and surveying of near and far-stretched fields. This data optimizes the application of fertilizers, water, seeds, and pesticides, driving precision agriculture. Moreover, drones facilitate livestock tracking, geofencing, and grazing monitoring. They fly over fields to capture images that range from simple visible-light photographs to multispectral imagery which helps in the crop, soil, and field analysis. Even though drones are not fit for poultry monitoring as their movement frightens birds, drones are effective for livestock monitoring, grazing monitoring, and crop cultivation. Start-ups are also working on drones capable of measuring the chlorophyll level, weed pressure, as well as soil mineral and chemical composition.

5. Precision Agriculture: Sustainability in agriculture refers to the use of eco-friendly methods and inputs which have zero or minimal negative impact on the environment. An example of this is site-specific crop and livestock management, commonly known as precision agriculture. It is a method in which farmers use exact amounts of input, such as water, pesticides, and fertilizers, to enhance the quality and productivity of yield. Different tracts of land across the field have different soil properties, receive different sunlight, and have different slopes. The same treatment for the whole farm, thus, is inefficient and leads to a wastage of time and resources. To tackle this, many AgriTech start-ups are developing solutions in precision agriculture to improve profitability while addressing sustainability challenges.

6. Big Data & Analytics: Big data and analytic techniques transform everyday farm data into actionable insights. Statistics of crop area, production, land use, irrigation, agricultural prices, weather forecasts, and crop diseases, lay the foundation for the next farming season. Analytical tools make use of data on weather events, farm equipment, water cycles, quality, and quantity of crops to extract information relevant to farm operations. This enables growers to identify patterns and relationships that may otherwise remain hidden. Several start-ups are offering solutions in the area of farm analytics that enable farmers to take advantage of their field data. For example, analytical data fosters an understanding of the soil nutrient levels, acidity, and alkalinity as well as fertilizer requirements, enabling data-driven decision-making.

7. Controlled Environment Agriculture: Fluctuating and extreme weather events constantly hamper conventional farming methods. Further, growing crops in populated cities, deserts, or other unfavourable conditions pose significant challenges. This is overcome by controlled environment agriculture (CEA). In CEA, plants are subjected to a controlled proportion of light, temperature, humidity, and nutrients. There are different growing environments, namely, indoor farming, vertical farming, and greenhouses, among others. There is an increased deployment of techniques like hydroponics and aeroponics which involve growing soilless plants in a liquid nutrient medium or steam. Another such technique is aquaponics, where plants and fish are cultivated simultaneously. Fish provides nutrients to plants while plants purify the water for the fish. CEA methods reduce pests and diseases, increase yield, and establish sustainable farming practices.

8. Regenerative Agriculture: Conventional farming practices lead to long-term erosion and crusting of soil. Often, the ploughing, tilling, and overgrazing don’t allow much time for the soil to revive before the next cropping season. Regenerative agriculture, on the other hand, causes minimal soil disturbance while focusing on improving soil biodiversity and topsoil revival. It involves different practices like no-till farming, reduced tillage, crop rotation, and more. For example, cover crops are planted to cover the soil between cropping seasons to restore soil fertility. Further, regenerative farming facilitates fields to act as a carbon sink through sequestration. This leads to fewer carbon emissions into the atmosphere and a lesser impact on climate change.

9. Connectivity Technologies: Smart farming is not possible without connectivity technologies like 5G, LPWAN, rural broadband, or satellite-enabled communication. 5G facilitates the adoption of IoT devices, robots, and sensors and enables them to communicate at high speeds. This enables farmers to monitor the data more accurately in real-time and take the required actions. High-speed internet using fibre optic cables aid the exchange of field data in real-time, which is crucial when it comes to improving accuracy. Connectivity technologies support other technologies like IoT, which ultimately work in coordination to form connected farms.

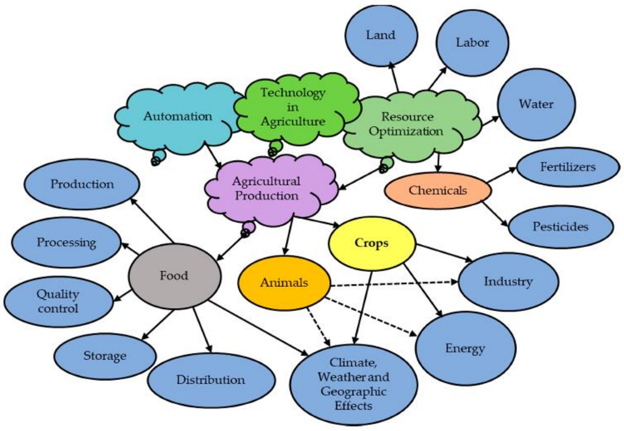

Fig. Various aspects involving in agricultural production

Conclusion

Smart farming reduces the ecological footprint of farming. Minimized or site-specific application of inputs, such as fertilizers and pesticides, in precision agriculture systems will mitigate leaching problems as well as the emission of greenhouse gases. With current Information and Communication Technology (ICT), it is possible to create a sensor network allowing for almost continuous monitoring of the farm. Similarly, theoretical and practical frameworks to connect the states of plants, animals, and soils with the needs for production inputs, such as water, fertilizer, and medications, are in reach with current ICT globally. Technology can help to earn foreign exchange for countries, increase productivity, and lead to an improvement in the overall standard of farmer communities. Technology in agriculture has the potential to truly lead India to be "Atmanirbhar Bharat" in all aspects, and be less dependent on extraneous factors.



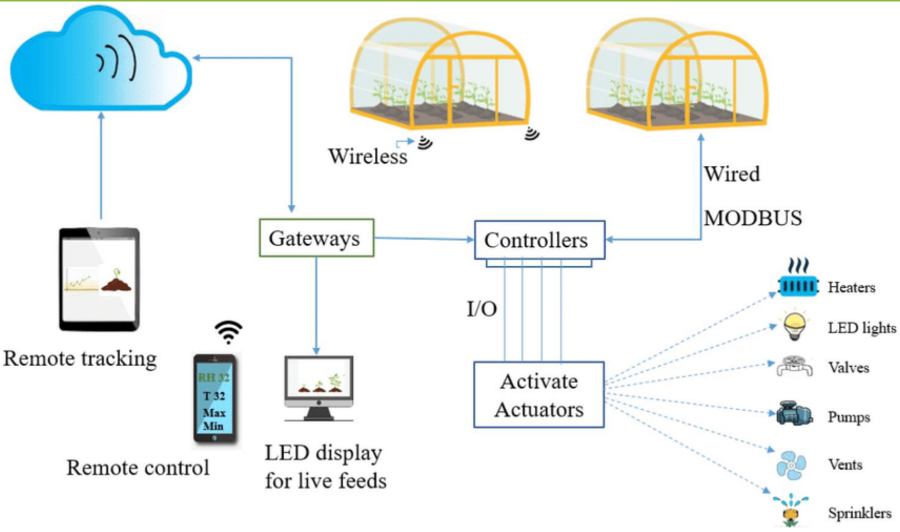

Fig. Envisioned technologies in agriculture

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Overview of Insurance Industry in India

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Aruna Prabha S[1], Deepa N[1]

[1]Ph.D. Scholar, Department of Agricultural and Rural Development, Centre of Agricultural and Rural Development Studies, Tamil Nadu Agricultural University, Coimbatore – 641003.

[2]Associate Professor (ARM), Department of Agricultural and Rural Development, Centre of Agricultural and Rural Development Studies, Tamil Nadu Agricultural University, Coimbatore – 641003.

Introduction

Insurance sector in India plays a dynamic role in the wellbeing of its economy. It substantially increases the opportunities for savings amongst the individuals, safeguards their future and helps the insurance sector form a massive pool of funds. With the help of these funds, the insurance sector highly contributes to the capital markets, thereby increasing large infrastructure developments in India.

The Indian Insurance Sector

India is ranked 11th in Global Insurance business. India's share in global insurance market was 1.72% during 2020 and total insurance premium volume in India increased by 0.1% (*investindia.gov.in*). In spite of it, there is a dearth of empirical research in developing countries and analytical studies are limited in number, particularly in developing countries like India, where the insurance penetration and density are very low compared with international levels (*Nagaraja, 2015*). The income earning capacity, eagerness and awareness of the general public are the key determinants of the growth of any insurance industry *(Bedi et. al., 2011).*

The Indian Insurance Sector is basically divided into two categories – Life Insurance and Non-life Insurance. The Non-life Insurance sector is also termed as General Insurance. Both the Life Insurance and the Non-life Insurance is governed by the IRDAI (Insurance Regulatory and Development Authority of India).The role of IRDA is to thoroughly monitor the entire insurance sector in India and also act like a custodian of all the insurance consumer rights. This is the reason all the insurers have to abide by the rules and regulations of the IRDAI.

The Insurance sector in India consists of total 57 insurance companies. Out of which 24 companies are the life insurance providers and the remaining 33 are non-life insurers. Out which there are seven public sector companies. Life insurance companies offer coverage to the life of the individuals, whereas the non-life insurance companies offer coverage with our day-to-day living like travel, health insurance, our car and bikes, and home insurance. Not only this, but the non-life insurance companies provide coverage for our industrial equipment's as well. Crop insurance for our farmers, gadget insurance for mobiles, pet insurance etc. are some more insurance products being made available by the general insurance companies in India.

Insurance Sector - Past

In the history of the Indian insurance sector, a decade back LIC was the only life insurance provider. Other public sector companies like the National Insurance, United India Insurance, Oriental Insurance and New India Assurance provided non-life insurance or say general insurance in India. However, with the introduction of new private sector companies, the insurance sector in India gained a momentum in the year 2000. Currently, 24 life insurance companies and 30 non-life insurance companies have been aggressive enough to rule the insurance sector in India.

Insurance Sector - Present

So far as the industry goes, LIC, New India, National Insurance, United insurance and Oriental are the only government ruled entity that stands high both in the market share as well as their contribution to the Insurance sector in India. There are two specialized insurers – Agriculture Insurance Company Ltd catering to Crop Insurance and Export Credit Guarantee of India catering to Credit Insurance. Whereas, others are the private insurers (both life and general) who have done a joint venture with foreign insurance companies to start their insurance businesses in India.

This collaboration with the foreign markets has made the Insurance Sector in India only grow tremendously with a high current market share. India allowed private companies in insurance sector in 2000, setting a limit on FDI to 26%, which was increased to 49% in 2014. IRDAI states – Insurance Laws (Amendment) Act, 2015 provides for enhancement of the Foreign Investment Cap in an Indian Insurance Company from 26% to an Explicitly Composite Limit of 49% with the safeguard of Indian Ownership and Control. Private insurers like HDFC, ICICI and SBI have been some tough competitors for providing life as well as non-life products to the insurance sector in India.

Insurance Sector - Future

With the increase in income and exponential growth of purchasing power as well as household savings, the insurance sector in India would introduce emerging trends like product innovation, multi-distribution, better claims management and regulatory trends in the Indian market. The government also strives hard to provide insurance to individuals in a below poverty line by introducing schemes like the

1. Pradhan Mantri Suraksha Bima Yojana (PMSBY),
2. Rashtriya Swasthya Bima Yojana (RSBY) and
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Technologies for Dryland Farming

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M. Nagarajan[1], G. Thiyagarajan[1], M. Manikandan[2], B. Suthakar[1], V. Sivakumar[3]
[1]Agricultural Engineering College & Research Institute, TNAU, Kumulur, Tamil Nadu (621 712), India.
[2]Agricultural Research Station, TNAU, Kovilpatti, Tamil Nadu (628 501), India.
[3]Horticultural College & Research Institute, TNAU, Coimbatore, Tamil Nadu (641 003), India.

Introduction

Importance of Dry-land farming in India is increasing year by year. With the continuous growth in the size of the population in India, the gap between the requirements and supply of agricultural output is increasing slowly. Present rate of development of irrigation system and water potentiality of the country, it is estimated that at any point in time about 50% of cropped area in India will remain under the rainfed farming system. Such vast areas consume hardly 25% of the total fertilizer consumption of the country. Due to the poor level of management, crop productivity is low resulting in the socio-economic backwardness of the people

Dryland farming is an agricultural system for non-irrigated cultivation of land. Dryland farming is a practice of growing profitable crops without irrigation in areas that receive an annual rainfall of 500 mm or even less. Dryland farming is an improved system of cultivation whereby the maximum quantity of water is conserved by soil and water management. It is practiced in the more arid and desert areas of the country, including northwest and central India. Crops such as finger millet, minor millet, horse gram, and peas are grown in these types of conditions.

Methods of Irrigation

1. Random tied ridging:

a. The ridges are vertically tied at shorter interval to create rectangular water harvesting structures. During heavy rainy season it facilitates to infiltrate water to the soil.
b. The slight sloppiness in the tied ridges facilitates draining of excess water infiltrate into the soil.
c. It conserves soil and moisture in redsoils.

2. Broad beds and furrows:

a. It is suitable when the slope of the land is < 3%
b. The broad bed and furrow system is laid within the field boundaries.
c. The land levels taken and it is laid using either animal drawn or tractor drawn ridgers.
d. To control erosion and to conserve soil moisture in the soil during rainy days
e. Conserves soil moisture in dryland farming
f. Controls soil erosion.
g. Acts as a drainage channel during heavy rainy days.

3. Chisel plough:

a. The main function of this plough is to loosen and aerate the soils while leaving crop residue at top of the soil.

b. This plough can be used to reduce effects of compaction and help to break up the ploughpan and hardpan.

c. Unlike many other ploughs the chisel will not invert or turn the soil.

d. This characteristic has made it a useful addition to no-till and low till farming practices which attempt to minimize the soil erosion.

e. Prevents formation of surface crusts, which helps water to infiltrate the soil

f. Chisel ploughing severe weed roots below the surface.

4. Ridges and furrows:

a. Ridges and furrows thus formed act as continuous barrier to the free movement of water downwards thus provides more infiltration time.

b. The removal of soil along with nutrients is checked to a greater extent leading to increment in soil fertility and crop yield.

c. Ridges and furrows is one of the various in situ soil and water conservation methods for black and red soils cause an increase of up to 15 per cent in crop yields.

5. Compartmental bunding:

a. Compartmental bunding conserves the rainwater in situ, recharges soil profile uniformly, reduces runoff, soil and nutrient losses and increases crop yields on a sustainable basis.
b. This technology is simple and low cost and can be adopted by the farmers easily in the medium to deep black soils in the region. Compartments of different sizes are formed with the bund former depending upon soil type and slope to conserve rainwater in situ.
c. Compartmental bunds in medium to deep black soils are formed after preliminary tillage operations are completed.
d. The sizes of the compartments with land slope are < 2% is 10 x 10 m and >2% is 5 x 5 m.

Conclusions

Dry-land farming in India is to cover rain-fed agricultural operations dominated by low water requiring crops in those arid and semi-arid tropical regions. To practice dry-land farming requires alternate farm seasons of cropping and fallows which again need careful plowing and harrowing during the cropping and fallow season. Black soil is mainly suitable for dry farming as it is fine-grained; rich in calcium and it can retain moisture to a large level and sticky. The above techniques should be adopted for dry land farming to achieve profitable yield.

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Balance Nutrition System for Improving the Productivity and Quality of Pulses

Article ID: 40737

K. Rajkumar[1], R. Hema[1]
[1]Assistant Professor, Department of Soil Science & Agricultural Chemistry, School of Agricultural Science, SMVE, Madagadipet, Pondicherry.

Introduction

Pulses have a significant role in enhancing food and nutritional security, replenishing soil nutrients and meeting future global demands for food security, nutrition, and environmental sustainability. Pulses provide both big and small farmers significant financial potential to increase revenue and lower risk by diversifying their crop and income stream mix. In addition to the environmental advantages of including pulses in crop rotations, producing pulses also has social and economic advantages because it meets the demand for protein, reduces soil erosion, and promotes food production and consumption diversification. Pulse producers and all other stakeholders must be aware of the effects of increased pulse production and consumption on their livelihoods and on the development of their communities.

Importance of Pulses in Human Nutrition

1. With a low glycemic index, low fat and high fibre content, pulses are suitable for people with diabetes. Pulses increase satiety and help to stabilize blood sugar and insulin levels by reducing spikes after eating and improving insulin resistance making pulses an ideal food for weight management.
2. Pulses may reduce the risks of coronary heart disease. They are high in dietary fibre, which is well known for reducing LDL cholesterol, a recognized risk factor in coronary heart disease.
3. Pulses are good sources of vitamins, such as folate, which reduces the risk of neural tube defects (NTDs) like spina bifida in newborn babie.
4. Pulses' high iron content makes them a potent food for preventing iron deficiency anaemia in women and children especially when combined with food containing vitamin C to improve iron absorption
5. Protein quality matters, particularly for growth and development. The protein quality of vegetarian diets and plant-based diets is significantly improved when pulses are eaten together with cereals.
6. Pulses are gluten-free
7. Pulses are rich in bioactive compounds such as phytochemicals and antioxidants that may contain anti-cancer properties
8. Pulses promote bone health
9. Phytoestrogens may also prevent cognitive decline and reduce menopausal symptoms.

Benefits of Pulses Production

1. Environmental benefits - Nitrogen fixation: The most widely used and most lacking plant nutrient in soils all over the world is nitrogen, which is present in synthetic fertilizer. Pulses serve a special function in the global nitrogen cycle because they make soils nitrogen self-sufficient by fixing atmospheric nitrogen through symbiotic associations with rhizobia, soil bacteria. This enables them to flourish in virtually any soil without the need of fertilizer.

Wheat, rice, and other cereal crops use 40% of the fertilizer utilized, causing significant waste and adverse environmental effects such eutrophication of coastal waterways and the formation of hypoxic zones. Pulses lower the need for fertilizer for both the current crop and the cereal crop that follows by being incorporated into crop rotation. The two most significant treatments to reduce nitrogen application are systematic crop rotation based on include pulses in cereal-based systems and improving the time and quantities of fertilizer applied to crops. (Lal, 2017).

2. Social Benefits - Nutrition: It is established fact that a human body requires a daily intake of about 50 gm of protein. Whereas, in India the per capita daily intake is only about 10 gm have direct bearing on health and affects work performance of the people. Out of the 22 amino acids required in the human diet, the body supplies 14, the rest eight have to come from food If all the eight amino acids are present in a single food item, it is called a complete protein food. For vegetarian population the main sources of protein are leguminous plants to which the pulses belong. Eighty-four percent of the protein in common bean is readily absorbed after consumption, and 94% of the protein from cowpea is available However, in general, pulses have lower concentrations of protein than animal sources. Besides, none of the pulses except soybeans are complete proteins. Therefore, combinations of two or more pulses are needed in a vegetarian diet. Given the important role that pulses play in the human diet, their availability needs to be increased indigenously. Pulses consumption levels has declined globally and in particular among developing countries as in China's from 30 g per capita per day in 1963, to only 3 g per capita. Pulses in India are source of protein accounting for almost 13% of overall protein intake (Goyal *et al.,*2018).

3. Economic Benefits: Farmers who grow grains and oilseeds have discovered financial benefits from lower input costs and increased profits by incorporating pulse crops into their rotation. These advantages result from improved nitrogen fertilizer use efficiency, decreased tillage and in some cases reduced pesticide use. Reduced and modified tillage techniques result in less dependency on fossil fuels and reduced total fuel costs. Pulses in no-till systems offer a foundation for integrated crop management strategies and sustainable agricultural intensification. No-till farming is thought to save farmers between 30- and 40% more-time, labour, and fossil fuels than traditional tillage. (Goyal *et al.,*2018).

Table 1: Effect of phosphorus and sulphur fertilization on seed yields and protein content black gram:

Treatments	Seed yield (kg/ha1)	Protein content (%)
A. Phosphorus levels (kg/ha1)		
0	663	20.38
20	881	22.38
40	974	23.94
60	1001	24.00
SEm+	21.11	0.52
CD (p=0.05)	60.96	1.52
B. Sulphur levels(kg/ha1)		
0	754	20.08
15	873	22.33
30	935	23.95
45	975	24.33
SEm+	21.11	0.52
CD(p=0.05)	60.96	1.52

Phosphorus

Data presented in table revealed that seed yield of black gram was significantly improved due to successive increase in level of phosphorus upto 40 kg/ha. It provided the seed yield of 974 kg/ha and thus showed a quantum increase of 93 and 218 kg/ha over 20 kg/ha and control, respectively. Application of phosphorus at 60 kg/ha recorded the highest yield of 1001 kg/ha, thereby increasing the seed yield by magnitude of 120 and 338 kg/ha over 20 kg/ha and control, respectively. However, it was found statistically at par with 40 kg/ha.

Sulphur

Further reference to data given in table and revealed that progressive increase in level of sulphur significantly increased the seed yield of black gram upto 30 kg/ha over lower levels and control. Remaining at par with 45 kg S/ha, it recorded 7.1 and 24.0 per cent higher seed yield than obtained under 15 kg/ha and control, respectively. The highest seed yield of 957 kg/ha was obtained with 45 kg S/ha. The corresponding increase noted due to this level of sulphur was 9.6 and 26.9 per cent.

Conclusions

Pulses are an important food legume that also improves soil fertility and contributes to the nutritional security of farmers. India requirement of pulses has been to reach 32 million tonnes by 2050 to keep pace with the growth of the population. Most of the farmer rice-pulse crops as rain fed and rice fellow pulses due to imbalanced nutrient yield will be reduced. Application recommended dose of P & S along with N, K are very much essential to improve the productivity and quality of pulses. Among the Micronutrient application Fe, B, Mo are improvement of productivity and quality of pulses. Application natural or synthetic chelates from micronutrient improve the yield as well as use efficiency of nutrient.

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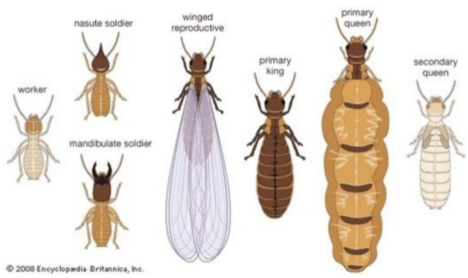
A Termite Bait Story: Colony Extermination of Subterranean Termites

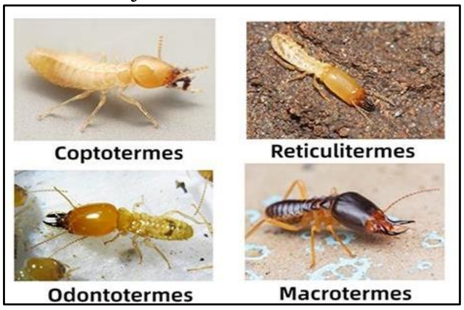
Article ID: 40738

Sangeeta Dash[1]
[1]Ph.D. Scholar, Department of Agricultural Entomology, IARI, New Delhi.

Introduction

In tropical and subtropical areas, termites are dominant invertebrate community that breaks down decaying organic debris. They belong to Blattodea order. The intricate social structure and their extraordinary capacity to consume woody plant material are credited with ensuring their ecological succession. They contribute to 10% of animal biomass and 95% of soil insect's biomass in tropics. Natural activity of termites promotes organic carbon, water content and porosity of soil; however, they are regarded as major pests for agricultural crops and wooden constructions. In 2010, the cost of termite damage was projected to be 40 billion USD, with subterranean termites making up 80% of this amount. Most of the annual losses are contributed by subterranean termites. Although rhinotermitids (37 species) make up the majority of these subterranean termites, certain termitid species like Odontotermes and Nasutitermes are soil-borne and hence also regarded as subterranean in actuality.





Early Techniques of Controlling Subterranean Termites

1. Applying arsenic dust locally to infested areas mostly colonies.
2. Baits incorporating arsenic and sugar
3. Use of chlorinated hydrocarbons like DDT, aldrin, chlordane, and dieldrin, etc

Yet, there was a need for a better strategy for controlling subterranean termite infestations because early methods utilising soil termiticides only functioned as a temporary fix in lowering termite colonies rather than addressing colony extermination. Several researchers kept testing the efficacy of poisonous baits and aimed to "eradicate a termite colony in the earth" in order to clear a broad area of termite infestation. The idea of baiting takes use of termites' inherent tendency to share food, known as trophallaxis.

Characteristics of Bait Toxicants

1. Transfer of toxicant used in bait must be through trophallaxis or food sharing
2. Toxic bait must be slow acting in order for nest mates to be exposed to it when foraging termites are intoxicated.
3. It should also be non-repellent.

Bait Toxicants Used

Dose-dependent lethal time (Lethal time depends on dose consumed by termites i.e., those who consume higher amounts die more quickly, and vice versa).

- **a. Mirex:** It was infused with the brown-rot fungus *Gloeophyllum trabeum* and impregnated in blocks of decaying wood.
- **b. Metabolic inhibitors** as hydramethylnon, avermectin, sulfuramid, and A- 9248

Dose-independent lethal time - Chitin synthesis inhibitors (CSI): It inhibits the moulting process of termites apart from being slow acting and non-repellent. Thus, termites ingesting lethal doses are unaffected till moulting starts. Further this inter-moult period is around 45 days in *Coptotermes formosanus* which is enough for most nest mates to be affected. Thus, colony termination was comparatively easy to achieve. Today, hexaflumuron is most frequently used CSI used in termite bait stations. Further it is observed that the workers in termite colony usually moult in the central chamber (where the royal pair resides) and die during the process. This induces the reproductive to shift away from the cadaver and in the process, they get further flanked by several CSI fed termites. This way the reproductive shift a multiple number of times and ultimately the colony collapses.

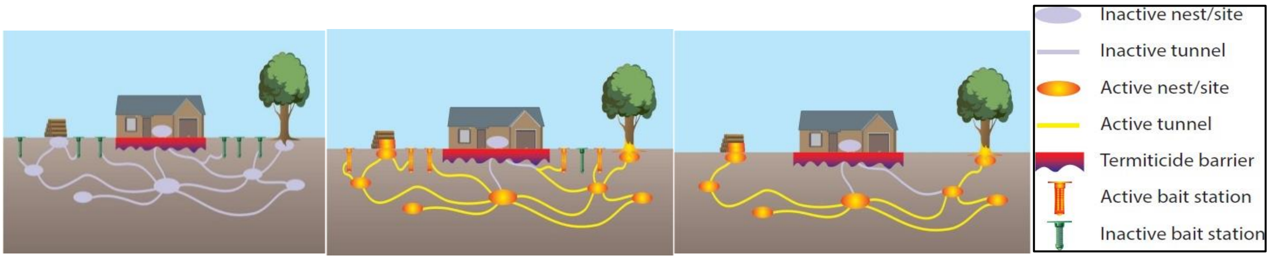
How does a Termite Bait Station Works?

Continuous death of the workers in the colony declines their population in the colony making food availability to other castes a big concern. The colony enters a suppression phase, or "declination," as a result of being food-starved.

1. Pre-baiting: Establishment of termite bait stations to be located by scout termites is the first step. The scout termites leave a pheromone trail to be detected by workers and feed on the bait. This establishes a solid feeding connection of bait stations with the termite colony. Termite detector stations only contain wood called detection wood or "interception" wood.

2. Incorporation of toxicant: Later, the wood in these stations is replaced with toxicants. Thus the workers die during moulting due to toxicants. The dose of toxicants depends on colony size and the population of termites.

3. Colony control: As workers are killed food supply to the colony diminishes. The colony soon depletes of its internal food sources too. This causes other castes to starve due to non-availability of food and the colony crashes soon.



Environmental Impact of Baiting System

A baiting system has a 19,200-fold lower environmental impact than soil termiticide treatments because it typically uses 600 times less pesticide than conventional soil termiticide applications and because bait like noviflumuron is 32 times less toxic than the most widely used soil termiticide fipronil.

Advantages of Termite Bait Systems

1. Helps in early detection and monitoring
2. Eco-friendly method of termite management
3. Safe for children and pets as it uses non-toxic chemicals.

Challenges to be Faced

1. Time necessary for complete colony elimination is higher
2. Standard procedures need to be adopted for improvement of bait efficacy
3. Frequent monitoring of the system is required.

Commercial Products

Noviflumuron (Sentricon), diflubenzuron (Advance, Isopthor), hexaflumuron (Shatter, Terminate), novaluron (Trelona), chlorfluazuron (Exterra) and bistrifluron (Xterm) are available for control of subterranean termites.

Conclusion

The conventional liquid termiticides have limited effect in eliminating colonies as compared to the CSI based baits. Thus, CSI based baits are preferred for area-wide management programs, to eliminate subterranean termite colonies around the structure.

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Management of Water lettuce (*Pistia stratiotes* L.) - An Invasive Weed in Paddy Fields

Article ID: 40739

Dr. R. Nageswari[1], Dr. S. Anandhakrishnaveni[1], Dr. K. Manikandan[1], Dr. K. Subrahmaniyan[1]
[1]Tamil Nadu Rice Research Institute, Tamil Nadu Agricultural University, Aduthurai, Thanjavur-612 101.

Rice in Cauvery delta region, is often observed with abundance growth of Water lettuce (*Pistia stratiotes* L.), a free-floating aquatic, mocotyledonous type of weed. It is also termed as water cabbage, water lettuce, Nile cabbage, or shellflower. It belongs to the family Aracea. It is a pantropical weed observed in most parts of the World except Antartica. It might have originated from Africa or South America (Howard et.al., 2023).

Botanical Description

Water lettuce (*Pistia stratiotes* L.) looks like the head of commerically cultivated lettuce. It is usually found as a floating mass of light green leaves on the water surface. The leaves are pale green and grow up to 30cm long. They lack leaf stalk and grow in a cluster of several leaves (a rosette). The leaves are thick, hairy, spongy and ridged. The spongy tissue and air trapped by the hairs enable the leaves to float on water. The roots are numerous and feathery and may extend 50-80cm below the leaves. Water lettuce propagates by production of daughter plants attached to each other by stolons. The weed also propagates by seed.

Fig.1.a &b. Morphological characteristics of Water lettuce (*Pistia stratiotes* L.)

Habitat

Water lettuce is found in drainage canals and rice fields in all the irrigation schemes in East Africa.Water lettuce (*Pistia stratiotes* L.) forms dense floating mats on rivers, dams, irrigation canals, channels, slow-moving streams, drainage ditches, ponds, lakes, springs, surface flow wetlands, reservoirs, polluted water (Parsons & Cuthbertson, 2001), nearly dried-out lagoons, mud at water's edge, rice paddies. It grows in nutrient rich, muddy water, low light intensities. It can survive for long periods when stranded on mud banks or in other damp situations such as a roadside culvert where it may even take root". The water lettuce mats clog the drainage canals leading to difficulties in irrigating rice fields.

1. Obstruction of the irrigation canals may lead to water deficiency resulting into losses associated with water deficiency in rice.
2. Water lettuce competes for space, light and nutrients leading to poor rice crop establishment and low yields.

Propagation

Water lettuce is propagated by sexual and vegetative means. Flowering and reproduction commence when the plant is in the 4th or 5th leaf stage, when plant densities are high. Water lettuce produces small pale green/white flowers in the middle of the leaf clusters which later forms fruits to produce seeds. (Perennial (Parsons & Cuthbertson 2001). Mature plant produces viable propagules for 3 – 10 years. These daughter plants are attached to each other by stolons and become separate individuals in a year. The plants are spread through waterways to other locations. The seeds are carried over by water, birds like pelicons and animals and spread in the newer areas.

Impact of Water Lettuce on Water Ways

Once established it spreads quickly over the entire surface of freshwater lakes, rivers and canals, impeding traffic and interfering with water flow and recreational activities. The dense mass reduces light penetration, oxygen concentration and pH levels in the water. May impact quality of stock drinking affected water and stock in infested aquaculture ponds major impact on quality of produce (e.g., 5-20%).

Water Lettuce in Rice Fields

Water lettuce (*Pistia stratiotes* L.) is a problematic weed in rice fields, as it creates hindrance to rice growth and competes for space and nutrients (Parsons & Cuthbertson 2001). Serious infestation reduces the yields of rice and also hampers in harvest of rice.

Fig. 2. Infestation of rice fields with water lettuce (*Pistia stratiotes L* .)

Physical Management Options

Water lettuce can be controlled by water level manipulations and mechanical removal of weeds by manual means which is supposed to be laborious. Mechanical weeding by weeders or small tools will be an economical way of reducing the weed population in addition to *insitu* incorporation of the weeds.

Chemical Control Method

The active ingredients that have been successful in treating water lettuce in rice fields include, Bispyribac, Imazapyr.

Biological Management Options

Insects such as the leaf weevil, *Neohydronomous affinis,* or leaf moth, *Spodoptera pectinicornis,* feed on water lettuce (Cilliers, 1991). They can be tried in open water ways to control water lettuce, but it was not evaluated in cultivated rice systems.

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Phage Display: A Broad Perspective on Application in Agriculture

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Krutika Patil[1]
[1]Division of Microbiology, ICAR-Indian Agricultural Research Institute, New Delhi-110012, India.

Phage display is a laboratory method for the investigation of protein-protein, protein-peptide, and protein-DNA interactions that links proteins with the genetic material that encodes them using bacteriophages (viruses that infect bacteria). This method establishes a link between genotype and phenotype by inserting a gene encoding a protein of interest into a phage coat protein gene, leading the phage to "display" the protein on its exterior while housing the gene for the protein on its interior. The interaction between the shown protein and other molecules can subsequently be discovered by screening these displaying phages against other proteins, peptides, or DNA sequences. In this way, a procedure equivalent to natural selection called *in vitro* selection is used to screen and amplify large libraries of proteins. The most common bacteriophages used in phage display are M13 and fd filamentous phage, however, T4, T7, and λ phage have also been used.

History

George P. Smith first introduced the concept of phage display in 1985. Lerner and Barbas (The Scripps Research Institute), Breitling and Dübel (German Cancer Research Center), and Greg Winter and John McCafferty (Laboratory of Molecular Biology) further advanced phage display technology for the display of proteins like antibodies for therapeutic protein engineering. Smith and Winter were awarded Nobel Prize (2018) in chemistry for their contribution to phage display development.

Key Steps in Phage Display Technology

A traditional cloning techniques dsDNA replication form of the phage or phagemid genome is used in order to create phage display libraries.

↓

Libraries are transformed in competent *E. coli* cells and recombinant phages produced.

↓

The phage pool is then screened against a target of interest and phages binding to the target are recognized.

↓

The pool of the eluted high-affinity binders is propagated in *E. coli* and then individual clones isolated and characterized.

↓

Further tests are performed to verify the selected phages' specificity, determine their binding affinities and sequences of selected clones.

Applications in Agriculture

1. Utilization in the plant defense against pathogens and herbivores:

a. Identification and production of protease inhibitors (PI): By the inhibition of the action of the pest digesting proteases, phytochemicals (PIs) can reduce nutrition uptake by pathogens or insects. The goal of using phage display to obtain novel PIs is to offer a wider variety of PIs that offer protection to plants than is possible with traditional plant breeding.

b. Detecting non-protease inhibitor protective peptides: The identification of peptides or proteins with affinity for a wide range of compounds is possible via phage display. Proteins essential to a pest's lifecycle can be disrupted by peptides with high affinity for those proteins.

c. Used in plant virology studies: Many plant virologists have utilised phage display to find peptides that attach to the coat protein of harmful viruses. The extracted peptides from the phage display were extremely sensitive and selective. They can be created as fusions with proteins that act as an antigen for antibody-reporter molecule conjugates, so at the very least they have diagnostic potential.

d. Identification of immune targets in plants: The first active line of defense is activated at the plant cell surface when microorganism-associated molecular patterns (MAMPs) like peptidoglycans, lipopolysaccharides, or bacterial flagellin are discovered by pattern recognition receptors (PRRs). By employing microbial cells as selection markers, recombinant phage display can be utilised to determine how plant proteins interact with various types of pathogens. In this manner, pathogen-binding abilities of plant proteins implicated in defence responses were discovered and then verified *in vitro*.

2. Applications in cell wall research: Enhancing enzymatic degradation is one strategy being studied for a more effective conversion of cellulose to glucose. Several cellulases and hemicellulases have been shown to maintain their activity when fused to a viral coat protein. These clones can then be modified to add new functionality or affinities to the displayed enzyme through a combinational approach. The resulting library of phage-displayed mutant enzymes can then be tested against substrates and inhibitors to examine whether specific amino acids are responsible for the desired trait.

3. Identification of allergens (seed storage proteins) with phage display: Phage display has enabled researchers to quickly identify antigens that cause hypersensitive reactions, even ones that weren't previously catalogued. Phage display has been utilised to pinpoint precisely which proteins in people with peanut sensitivity are resulting in the hypersensitive reaction.

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Bacterial Endophytes: Mysterious World within the Plant

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Krutika Patil[1]
[1]Division of Microbiology, ICAR-Indian Agricultural Research Institute, New Delhi-110012, India.

Bacterial endophytes are frequent inhabitants of the inner plant tissues, where they typically do not produce any significant morphological alterations and disease symptoms. The majority of endophytes colonise various apoplast compartments in plants, including the xylem vessels and intercellular spaces of cell walls. Some of them are able to colonise reproductive organs such as flowers, seeds and fruits.

Endophytes can be divided into three classes according to their nature:
1. Pathogens of another host which are non-pathogenic in their endophytic relationship;
2. Pathogens that have been considered nonpathogenic yet are able to colonise due to genetic modification or selection; and
3. Non-pathogenic microbes.

History

The term 'Entophytae' used to designate endophytes, was first coined by German botanist Heinrich Friedrich Link in 1809. The word comes from the Greek nouns 'endon' which denotes 'inside' and 'phyton' which denotes 'plant' (given by Heinrich Anton De Bary, 1866).

Colonization of Plants by Endophytic Bacteria

1. Rhizoplane colonization: The establishment of bacteria in the rhizosphere typically marks the beginning of their colonisation of the plant's interior. Following which they adhere to the rhizoplane or the root surface.

2. Bacterial Entry: The apical root zone, the root hair zone (zone of active penetration), and the basal root zone (zone of passive penetration) are the desirable locations for bacterial adhesion and successive entry. Endophytes can either stay at the point of entry or travel farther within to take up residence in the cortex and xylem vessels' intercellular space.

3. Colonization of the xylem and reproductive organs: Few bacteria are able to enter the xylem vessels through the endodermal barrier with the help of unsuberized endodermal cells in the apical and basal root zone. Presumably, bacterial cells enter the reproductive organs either via the plant's vascular tissues of funiculus and chalaze region or stigma and micropyle.

Beneficial Effects of Bacterial Endophytes

1. Plant hormone stimulation: The well-studied mechanism for promoting plant growth by endophytes is their capability to produce auxins, cytokinins and gibberellins. For example, indole-3-acetic acid (IAA), from a group of auxins, contributes to cell division and differentiation which eventually improves root length, root hair abundance and root surface area resulting in enhancement of plant's ability to absorb more nutrients.

2. Production of antibiotic secondary metabolites: Secondary metabolites produced by endophytes have a role in the defence, signalling and genetic regulation for symbiosis establishment. Many antifungal substances, such as phenazine-1-carboxylic acid, 2, 4-diacetylphloroglucinol, pyrrolnitrin, pyoleutirin, 2, 4 diacetylphloroglucinol (DAPG), and volatiles such as hydrogen cyanide compounds, are produced by bacteria which extensively limit growth of fungal pathogens and thereby increases disease suppression ability in plants.

3. Nutrient availability: Another mechanism for promoting plant growth is nitrogen fixation. The rhizobial and actinorhizal plant symbioses are well studied for this purpose. A number of root endophytes fix nitrogen (e.g., *Azospirillum* sp., *Azoarcus* sp. and *Herbaspirillum* sp.). Not only this, by producing organic acids like gluconic acid and a variety of enzymes like non-specific phosphatase and C-P lyases, phosphate-solubilizing bacteria like *Bacillus, Enterobacter*, *Erwinia* and *Pseudomonas* sp. can solubilize bound phosphorous from organic or inorganic compounds.

4. Iron homeostasis: Siderophores are low-molecular-weight compounds having great specificity and affinity towards iron. Endophytes boost plant development directly by making more iron available in the soil around the roots or indirectly by preventing the growth of plant diseases with inefficient iron uptake systems by producing siderophores like pyochelin and salicylic acid.

5. Protection against abiotic stresses: A bacterial enzyme known as ACC deaminase is frequently linked to the reduction of plant stress. By converting the ethylene precursor, 1-aminocyclopropane-1-carboxylate (ACC), to ammonia and 2-oxobutanoate, this enzyme lowers the amounts of ethylene in the plant and thus blocks ethylene signalling. In order to decrease the natural ACC level in plant roots, ACC deaminase producing endophytes are used to boost plant tolerance to stresses and increase root and shoot length, seed germination, leaf area and numbers.

The interior spaces of plants become unfavourable for aerobic bacteria because of the release of reactive oxygen species (ROS) and reactive nitrogen species (RNS). The ROS- and RNS-scavenging enzymes such as superoxide dismutase (SOD) and glutathione reductase (GR) produced by endophytes manage the plant's oxidative burst thus shielding plant cells from oxidative damage.

Beneficial Endophytes and their Mechanism of Action

Sl. No	Endophyte	Mechanism
1.	*Bacillus subtilis*	Antibiosis, Production of lipopolypeptides
2.	*Gluconacetbacter diazotrophicus*	N2 fixation, P and Zn solubilization, Production of phytohormones
3.	*Burkholderia phytofirmans*	Production of siderophores
4.	*Azhospirillum sp.*	N2 fixation, Induced Systemic Resistance, Siderophore production
5.	*Pseudomonas putida*	ROS scavenging ability, Osmolyte accumulation

Conclusion

Endophytes are unique due to their capacity to enter and flourish in the tissues of their hosts, demonstrating complex relationships with the host plant. The tissue type, host and microbe genotypes, environmental factors influence endophyte establishment within the plant. The key to replacing heavy agrochemical input in agricultural systems is to take advantage of endophytic microbes' potential for soil quality improvement, disease and stress tolerance, plant growth promotion, phytoremediation, reclamation of disturbed soils, etc. Hence, a thorough understanding of the composition and operation of the microbial communities that are connected with plants has enormous potential to promote plant development and improve soil quality.

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Cisgenics and its Role in Crop Improvement

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Dr. Priyanka Veerala[1], Dr. Rahul Kumar[2]
[1]Assistant professor, SOAS, Mallareddy university, Dulapally, Hyderabad-500043.
[2]Senior executive, Breeding section, UPL company, Pune-412207.

There is a need for the advances in biotechnological tools which enhancesthe genetic architecture of cultivatable crops by introducing novel genes isolated from non-crossable species for sufficient food production. However, the testing, release and public acceptance of the genetically modified plants are tightly regulated to monitor the negative effect on the environments or human health. Hence, cisgenesis will be a better option in these regards and will overlay the way towards sustainable crop improvement (Telem *et al.* 2013).

"Cisgenesis is the genetic modification of a recipient organism with a gene from a crossable – sexually compatible organismorspecific alleles/genes in the breeder's gene pool are introduced into new varieties without the accompanying linkage drag. Furthermore, cisgenics are devoid of foreign sequences including selectable marker gene, vector backbone genes. The gene construct of cisgenic plants contains only endogenous gene including the promoter, intron, and terminator in the normal sense orientation and except the T-DNA borders from *Agrobacterium* (Schouten *et al.* 2006) However now a days there are suitable plant transfer DNAs (P-DNAs) resembling T-DNA borders of *Agrobacterium* which lacks the open reading frame and high A/T contents that are isolated from the sexually compatible species (Holme *et al.*2013).

Components

Cisgenic can harbour	Intragenic can harbour
One or more identical copy of the endogenous gene including its promoter, introns & the terminator.	Coding regions of 1 gene can combine with the promoters & terminators from different genes of the sexually compatible gene pool.
No in vitro arrangements	Combination of genetic elements from sexually compatible gene pool.
No strict use of P –DNA borders.	Use of P- DNA borders
Native form of gene.	In vitro arrangement

Different ORF Constructs

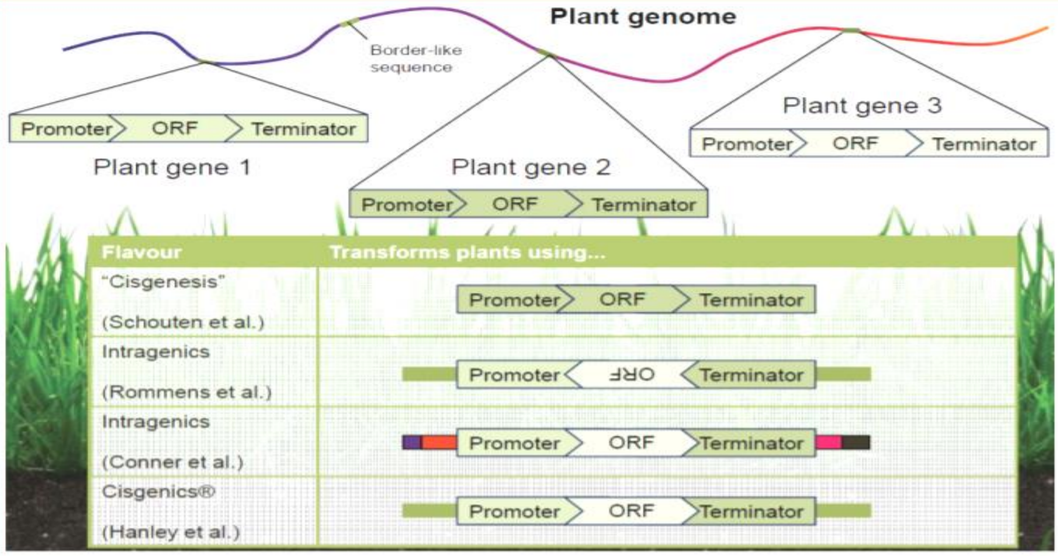

Figure 2: Open reading frame composition of different X-genic principles. Source: (Hanley, 2009)

Need for Cisgenics

The need for cisgenics is known, when the problems related to different breeding methods are taken in to account

1. Transgenic approach
2. Traditional breeding
3. Induced Translocation breeding.

How Cisgenics can Overcome Problems of Existing Methods

1. No change in fitness
2. No risk on non-target organism ecosystem
3. No alteration in gene pool
4. No additional traits in recipient species
5. To produce cisgenic plants any suitable technique used for production of transgenic organisms may be used.

Pre-Requisites for a Cisgenic Plant

1. Sequence information of plant
2. The isolation and characterization of gene of interest from crossable relatives
3. Transformation technique
4. Marker free transformation
5. Intragenic vectors development.

Methods to Produce the Marker Free Cisgenic Plant

1. Transformation without marker
2. Co- transformation
3. Site – specific recombinase mediated marker
4. Transposon- based expelling systems
5. Intrachromosomal recombination-based excision.

Methods Used in Different Crops to Produce Marker Free Cisgenic Plants

Crop	Gene	Method of delivery	Marker free method	P-DNA borders	Vector–backbone detection
Potato	*GBSS* *R- genes*	*Agrobacterium*	Transformation without marker gene	No	PCR & Southern blot
Potato	*R1, PhL*	*Agrobacterium*	*Co-transformation with vector (NptII/ CodA)*	Yes	*Ipt in vector-backbone*
Strawberry	*PGIP*	*Agrobacterium*	Site specific recombination (R/RS)	No	PCR & Southern blot
Apple	*Rvi6 (HcrVf2)*	*Agrobacterium*	Site specific recombination (R/RS)	No	PCR & Southern blot
Barley	*HvPAPhy_ a*	*Agrobacterium*	Co-transformation with vector with marker gene	No	PCR, flanking sequence analysis
Wheat	*1Dy10*	Biolistic	Co-transformation of linear fragments with GOI & marker gene	No	Not applicable

(Holme *et al.*, 2013)

Applications of Cisgenesis

1. Cisgenesis has been widely applied both in basic research & in breeding.
2. Extensively used for obtaining disease resistance in potato & apple.
3. It has also been applied for fungal disease resistance in grapevine, strawberry & melon etc.

Others like:

a. Higher feed quality in barley,
b. Baking quality in wheat,
c. Drought tolerance in perennial ryegrass &
d. To limit acrylamide content in french fries.

Cisgenic Crops Currently Under Development

(Cisgenic)Crop	Type / Genes from	Trait	Gene	Reference
Potato	Expression (Genes from *S. bulbocastanum, venturi, demissum etc.)*	Late blight resistance	*R - genes*	Haverkort *et al.,* (2009) Jo *et al.,* (2014)
Apple	Expression (Genes from related species *Malus floribunda)*	Scab resistance	*Rvi6 (HcrVf2)*	Vanblaere *et al.,* (2011)
Grapevine	Expression (Genes from related species)	Fungal disease resistance	*VVTL -1*	Dhekney *et al.,* (2011) Espinoza *et al.,* (2013)
Woody species				
Poplar	Over expression (Genes from related species) *Populus trichocarpa clone Nisqually-1*	Different growth types	*Genes involved in growth (PtGA)*	Han *et al., (2011)*
Seed propagated /self pollinating crops				
Barley	Over expression (Genes from related species)	Improved grain phytase quality	*HvPAPhy _ a*	Holme *et al., (2012)*
Durum wheat	Expression (Genes from related species)	Improved baking quality	1Dy10	Gadaleta *et al., (2008)*

(Telem *et al.,* 2013)

Use of Cisgenics in Crop Improvement

1. S- cisgenes could be used for developing inbred lines and/or seed producing hybrid varieties by inhibiting self-incompatibility. (Jacobsen and Schouten., 2010)
2. Manipulation of CMS and its restoration by the GM approach is possible, when cisgenes could be involved. In several species like maize (T-urf13), bean (pvs-orf239), *Brassica* (orf138) and Petunia (pcf) the CMS-genes involved have been identified.
3. Higher expression level of a trait can be obtained by re-introducing the gene of the trait with its own promoter and terminator. e.g. : Barley
4. The risk of linkage drag and the time required is greatly reduced. (high specificity & efficiency can be achieved)
5. An alternative to transgenics and in case of vegetatively propagated crops such as potato, apple, strawberry, grapes etc., it is feasible to maintain the original genetic make–up of the cultivars with minor changes. (Holme *et al.* 2013).

Conclusion and Future Prospects

To date, several field trials of cisgenic crops including vegetatively propagating, woody species, perennial grass and cereals has been performed in Europe, USA, and New Zealand (Hou *etal*. 2014). The crops obtained from cisgenics may be safer than the conventional bred and other transgenics hence it should be exempted from the regulatory frame work of GM technology.Thus,this technique provides a means for gene integration and transformation and results in general changes in structure and organization of the plant's genome as a result of the modification.

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Designer Foods: Moving Technology from the Lab to Plate

Article ID: 40743

Dr. Gitanjali Chaudhary[1], Dr. Neelam Kumari[2], Dr. Vishal Kumar[2]
[1]Assistant Professor, College of Community Science, RPCAU, Pusa.
[2]Assistant Professor, College of Agricultural Engineering, RPCAU, Pusa.

Designer food or functional foods are gaining greater importance in present scenario due to their role in disease prevention and health promotion. Designer food refers to the food that is designed to have some health benefits other than its nutritional value. 'Designer food', 'Functional food' and 'Fortified food' are synonym, which refers to the food fortified or enriched with nutrient content already present in them or another complementary nutrient. The term was firstly introduced in Japan in 1980s for referring processed food containing nutrient with some additional health benefits apart from its own nutritional value, whereas in China, designer food referred to as health foods which can be used as traditional medicine.

The Institute of Medicine's Food and Nutrition Board defined functional foods as "any food or food ingredient that may provide a health benefit beyond the traditional nutrients it contains". Functional foods included a wide variety of foods and food components believed to improve overall health and wellbeing, reduce the risk of specific diseases, or minimize the effects of other health concerns. It can be produced by fortification or enrichment of conventional food.

Genetically engineered foods containing higher amounts of health promoting nutrients and fermented foods with live cultures are considered functional foods. Infant formula may be considered as the designer food as it contains nutrients for the development of brain and immune system. The addition of docosahexaenoic acid to health foods for improving brain and visual development, the alteration or reduction of allergenic components in food, the use of probiotics and nucleotides to enhance immune response and sports nutrition are different examples of designer foods. In, India the Food Safety and Standards Authority of India (FSSAI), established under the Food Safety and Standards Act, 2006 as a statutory body for laying down science-based standards for articles of food and regulating manufacturing, processing, distribution, sale and import of food so as to ensure safe and wholesome food for human consumption.

Designer Eggs

The designer food approach has been explored widely using egg in providing various essential nutrients to the human body. Designer egg approach was started in 1934 by Cruickshank, who reported the modification of fatty acid composition in egg yolk by making feed interventions. By changing the diet of hens, designer eggs can be produced with improvement in nutritional content of eggs. Most "designer eggs" are enriched with omega-3 fatty acids, a heart healthy nutrient that is mainly found in seafood (Salmon), flaxseed and walnuts. The Manipulation in hen feed can also result in eggs with less cholesterol. Omega-3 fatty acids are proved to be beneficial in various disorders such as cardiovascular disease, hypertension, autoimmune, allergic, and neurological disorders. The consumption of these eggs improved the blood concentration of omega-3 fatty acids, high density lipoproteins, low density lipoproteins and triglycerides. Fortification of omega-3 fatty acid not only increases the health benefits of designer egg but also reduces the cholesterol content of the egg by replacing saturated fatty acid in egg yolk.

Designer Broccoli

Broccoli is a highly valued vegetable due to its chemo-preventive property. Designer broccoli fortified with Selenium is effective in cancer prevention. Selenium enrichment of broccoli showed potential anticancer properties in human prostate cancer cell lines.

Probiotics

Probiotics are live microorganisms such as *Lactobacilli Sp.*, *Bifidobacteria Sp.* and *Streptococcus thermophilus*, which provide various health benefits upon ingestion. These probiotics are commercially available as spores or in lyophilized forms or in the form of probiotic fortified fermented dairy products. Probiotics are potential in the treatment for eczema, pediatric antibiotic-associated diarrhea, acute upper respiratory tract infections, chronic and acute enteric infections and their associated diarrheal complexes. Daily dietary intake of probiotics reduces the incidence and severity of acute and chronic infection, prevents.

Designer Yogurt

Yogurt is an example of naturally available probiotic food. It contains live cultures of lactic acid-producing bacteria that can prevent diarrhea, antibiotic-induced diarrhea, rotavirus infection persistent diarrheal disease, inflammatory bowel disease etc. Regular consumption of probiotic yogurt can also improves fasting blood glucose and antioxidant status in type 2 diabetic patients.

Applications of Cisgenesis

1. Cisgenesis has been widely applied both in basic research & in breeding.
2. Extensively used for obtaining disease resistance in potato & apple.
3. It has also been applied for fungal disease resistance in grapevine, strawberry & melon etc.

Others like:

- a. Higher feed quality in barley,
- b. Baking quality in wheat,
- c. Drought tolerance in perennial ryegrass &
- d. To limit acrylamide content in french fries.

Kasha

Toasted buckwheat groats (kernels of buckwheat without the inedible shell) are more commonly known as kasha. These grains are packed with nutritional goodness, including dietary fiber, manganese, copper, selenium, zinc and phytochemicals. Kasha has a nutty flavor and can be used as breakfast cereal. It is a great grain choice for people having wheat allergies or gluten intolerance.

New Age Sparkling Juices

Indian gooseberry (Amla), blueberry, blackberry, orange juices etc are some of the good innovations in alternative ready to drink beverages. Responding to the demand of consumers for flavoured drinks without excess sugar or artificial additives ingredients many companies have introduced fruit juices made from pure fruit. These juices come in a variety of delicious flavours and also fortified with micronutrients and antioxidants.

Beans: Beans in general are one of the most healthful and economical sources of quality protein, containing fiber, vitamins, minerals, and phytochemicals. Diets high in beans can help to lower blood cholesterol levels and reduce blood sugar.

Designer milk: Designer milk may have modification in the primary structure of casein, alteration in the lipid profile to include more healthy fatty acids such as conjugated linoleic acid and omega-fatts and improved amino acid profiles and increased protein recovery. The genetic manipulation of dairy cattle can also a feasible and has significant impacts on milk quality. Various forms of designer milks and milk products were evaluated by researchers for the health benefits of human, which include milk-based beverages fortified with phenolic compounds from different fruits. Calcium and vitamin D fortified milk along with magnesium and zinc improves vitamin D status, lower parathyroid hormone levels and reduce bone turnover and prevent the occurrence of overweight and obesity among postmenopausal women.

Cholesterol Lowering Designer Food

Plant sources of phytosterols are oily seeds, nuts, plant oils, grains and pulses. Phytosterol chemically resembles cholesterol, inhibits the absorption of cholesterol. It has been reported that the consumption of 2–3 g phytosterols fortified foods per day may reduce the total cholesterol and LDL cholesterol level on consumption of food products fortified with phytosterols. Intake of phytosterols enriched designer oil might significantly reduced total cholesterol, very low density lipoprotein cholesterol and remnant-like lipoprotein cholesterol which is helpful in reducing the risk of coronary heart disease.

Role of Designer Foods in Cancer Prevention

There are numerous anti-carcinogenic compounds/ constituents available naturally in food or herbs. The effective use of those constituents is important in preventing the progression of cancer. The "designer foods" approach is one of the best approaches, by which the constituents having anti-cancer potential can be fortified into the regular diet. Polyphenolic compounds such as anthocyanins and flavonoids in red grape wine were proved to have inhibitory effect on breast cancer cells. Tea is consumed as beverage in many countries in the world. It has been also showed the beneficiary effect of tea in reducing the risk of a variety of illnesses such as cancer and coronary heart disease. Among tea, both black tea and green tea were proved to have potential in preventing lung, stomach, esophagus, duodenum, pancreas, liver, breast, colon and skin cancers and also have preventive effect on atherosclerosis and coronary heart disease.

Conclusion

Advantages of designer food approach are that it does not require change in dietary pattern of the population and it can deliver recommended amount of nutrients regularly. It can be easily merged with existing system of food production and distribution. In developed countries designer foods played a major role in improving the diet and eliminating nutritional deficiencies. In the developing countries, food fortification has gained importance since 1990s. Fortification of flour with iron, vitamin A, folic acid and other B vitamins was successful in eliminating these micronutrient deficiencies in developing countries. Designer foods approach is one of the major strategies to reduce micronutrient deficiency in developing countries. The best example for commonly used designer food was iodized salt, which is widely used by the population for elimination of iodine deficiency and its related disorders. In India, there is a cultural relationship between food and health, which is well recognized and used in day to day life. Food is considered as medicine in Indian systems of medicine. Regularly used foods in India such as tea, green tea, oil, sugar, dhal, etc. can be positively explored for designer foods approach in improving health of the society.

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Cultivation of Rice Under Drip Irrigation as a Water Management Strategy

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Shivani K V[1]
[1]S Thangapazham College of Agriculture.

Abstract

When people listen to this word "Drip in Rice" most of the people think that is it possible? and some of them assumes that it wouldn't happen. Drip irrigation is not only possible in horticultural crops, it is also possible in Rice. Continuous irrigation from natural resources such as fresh rain water sustain the expansion of rice plant in paddy fields, this is often an important a part of cereal agriculture for lowland rice with in the flood plains of tropical region. Continuous irrigation by artificial water of land is the major challenge for upland rice in North India, where precipitation is low and dependence on nutrients dissolved in soil moisture.

Due to water scarcity, Rice cultivation is becoming unaffordable and unpredictable in many areas across the world. The use of Drip irrigation in rice combined with fertigation has a benefit for rice production. At one side the water consumption is reduced to a great extent when we use drip and at the same time under non-stress situation paddy respond with higher yields. Using Drip irrigation with 50 to 60 lakh litres of water in 1 ha, around 5 to 6.5 tonnes of rice was produced, this was more effective than existing method of irrigation. Demand for rice is expected to rise 25% by 2050 and there is 30 to 40% deficit of underground water. In order to meet the demand of rice production and conserve ground water resources for future we have to go for precision water management which is achieved by Micro irrigation system. Drip irrigation shows impressive results, doubling water productivity, and "getting more grain for every drop".

Keywords: Drip irrigation, flooding, rice, water productivity, yield.

Introduction

Water is one of the most critical inputs for life on this earth. But due to indiscriminate and unscrupulous exploitation by users, its availability and accessibility in terms of quantity is reducing. If this trend continues, affordability of water will be a great challenge in future. When annual per capita water availability becomes less than 1700 m3, it is categorized under water stressed condition and by the year 2025, India will become water stressed country. If it declines further to around 1,000-1,100 m3, it will become more serious water scarce condition. (The Hindu, 2019).

The present status of efficiencies of various irrigation systems shows that conveyance efficiency of surface water through unlined canal and through lined canal vary from 55 to 60% and 70 to 75%, respectively.

As of now irrigation sector consumes about 80% of the total water use, which may reduce to about 70% by 2050 due to competing demands from other sectors. Most of the irrigation projects are very old and have become less efficient. Given the quantum of use in this sector, it is needless to emphasize that it has tremendous potential for water saving on efficient irrigation water use.

Conservation Methods Used in Agriculture

There are a number of important water conservation methods used in agriculture; they are oriented either towards 'water', 'soil' or 'crops'. One group of them is concerned with avoidance of water losses, e.g. (1) in conveyance and distribution, (2) in application of irrigation water, (3) of stored water, (4) of evaporation from soil, (5) of deep percolation from soil and (6) reduction of transpiration.

Other methods and techniques to conserve irrigation water deal with (1) use of efficient irrigation methods, (2) use of efficient water application techniques, (3) more rational use of irrigation water, (4) improving water availability to crops, (5) improving crop selection, (6) improving crop husbandry and (7) combining cropping with animal husbandry.

Cultivation of Rice

Rice is the most important food crop with more than 90% produced in Asia, providing on average, 32% of total calorie uptake. About 75% of the global rice volume is produced in the irrigated lowlands (MacLean *et al*., 2002). Rice is typically grown in bunded fields that are continuously flooded up to 7-10 days before harvest. Continuous flooding helps ensure sufficient water and control weeds. Lowland rice requires a lot of water. Irrigated rice has very low water use efficiency as it consumes as high as 6667 liters of water to produce one kg (0.15 kg of milled rice / m3) of rice (FAO 2002).

Decreasing water availability for agriculture threatens the productivity of the irrigated rice ecosystem and ways must be sought to save water and increase the water productivity of rice (Guerra *et al*., 1998).

Water inputs can be reduced and water productivity increased by introducing periods of no submerged conditions of several days throughout the growing season until cracks are formed through the plough sole (Bouman and Tuong, 2001). It is worth mentioning utilization, especially, usage of nitrogen fertilizer is very significant factor in the growth of rice. When nitrogen fertilizer is used in tillering, paddy yield increased with significantly higher water productivity.

Direct seeded rice (DSR) cultivation combined with micro irrigation and aerobic rice cultivation will curb methane production and saves water without affecting the productivity.

Rice Production Systems Under Limited Water Supply Condition

Rice is an obvious target for water conservation, it is grown on more than 30% of irrigated land and accounts for 50% of irrigation water (Barker *et al*., 1999). Reducing water input in rice production can have a high societal and environmental impact if the water saved can be diverted to areas where competition is high. A reduction of 10% in water used in irrigated rice.

Drip-irrigated rice crops in Turkey. (Netafim)

At present water scarcity increases due to erratic rainfall and over exploitation of ground water. There is no option except to adopt advanced irrigation systems such as drip in order to bring more area under cultivation with depleting water resources. Micro irrigation system has an ability to maintain soil moisture in the rice field at saturation level continuously with minimum or no losses of field water through seepage and deep percolation besides elimination of conveyance losses. Therefore, all the irrigation efficiencies reducing arameters are eliminated or minimized which increases the water use efficiency / water productivity. Drip irrigation with small and frequent water application has been found superior in terms of yield, irrigation water saving and water productivity/water use efficiency.

Why Cultivate Rice through Drip Irrigation?

Grow More in Less Water: Drip irrigation reduces water use through a precise water supply to the crop. So, for the one kilo of rice that you used to grow in 5000 liters of water conventionally, you now need only 1500-1600 liters. On a large scale, you achieve a higher crop yield in lesser water.

Shift to High-Income Crops: Drip irrigation allows you to choose any desired close spacing crop after rice in crop rotation. You can also shift from low-income crops to high-income ones after cultivating rice.

Grow High-Quality Marketable Rice Crop: In paddy farming, rice roots remain submerged. They consume heavy metals and increase the arsenic in the crop, thereby reducing the crop's market value.

However, in drip irrigation, it helps reduce the arsenic uptake by around 90%, and further results in the growth of a high-quality and marketable crop.

Higher Profit-Earnings: With drip irrigation, you reduce labor costs, achieve water efficiency, increase crop yield, improve crop quality. All of these factors reduce investments and increase profits.

Eco-Friendly Irrigation Solution: Paddy cultivation produces around 10% of methane gas emissions globally. But, even if only 10% of paddy rice cultivators upgrade to drip irrigation, the world will be able to reduce methane emissions equivalent to those of a staggering 40 million cars.

Advantages from Adoption of Drip Irrigation System in Rice

1. Grow more with less water.
2. 70 to 80 % water saving.
3. Reduces methane emission.
4. Reduce weed growth.
5. Decreases cost of cultivation.
6. Increases Water use efficiency.
7. Reduces fertilizer losses.
8. Reduce Arsenic uptake up to 90%.
9. To increase the more area under cultivation of paddy in rabi season than kharif season which may result in ultimate production.
10. Fertigation is the technique of application of fertilizers along with drip irrigation system which helps in not only increasing fertilizer use efficiency but also helps in saving of fertilizers.

Success Story

Mr. Parthasarathy is a farmer from Tirupur district, Tamilnadu. He received "Innovative Rice Farmer Award". For his contribution by use of drip irrigation system in his paddy field. He reported yield in his field was 6 t/ha. He experienced 15 to 20 % improvement in yield with water saving of 30 to 40% through Drip irrigation system.

Conclusion

Many people assumed that paddy can be cultivated by only long-term stagnant water but this assumption can be overcome by Drip irrigation system. Drip irrigation system has assured to sustain the productivity under water scarcity conditions. Precise water management is crucial not only to address to handle the growing water inadequacy, however it also helps to break the yield paradigm barrier through best weed management and correct nutrient delivery to the plants. Considering its several advantages by drip irrigation could also be the "need of the hour", however its implementation poses a few important challenges like capital cost of drip irrigation system, which is cannot afford by marginal farmers, lack of awareness among farmers to adopt this technology.

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Hi-Tech Vegetable Cultivation Using Pro-Trays Nursery

Article ID: 40745

Pankaj Kumar Ray[1], Pallavi Bharti[2]
[1]Subject Matter Specialist, Krishi Vigyan Kendra, Saharsa, Bihar.
[2]Research Scholar, Birsa Agricultural University, Ranchi, Jharkhand.

Introduction

Selection of healthy and vigorous seedlings free from pest and disease is very important for maximization of yield and quality of the vegetable produce. Generally several factors are affecting the quality of vegetable seedlings viz., water, temperature, Sunlight, cell size of the pro-trays and age of the seedlings for transplanting. To produce quality seedlings, the following factors are important.

1. Selection of hybrids / varieties.
2. Quality of seeds and its handling.
3. Method of seedlings production.

Among four stages of vegetable seedling production, first two stages determine the germinability of the seeds. Of which the first stage starts with seed sowing and maintaining the media with optimum moisture to induce germination and root growth. The second stage will extend upto stretching of roots and cotyledon opening. Third stage includes full growth of roots and first leaf emergence after cotyledon. Fourth stage is hardening stage which includes seedling treatment before transplanting. At every stage of nursery period, moisture and temperature requirement is declined and requirement of sunlight and nutrient is increased.

At present, seedlings are raised in two methods viz., growing seedlings in raised beds and protrays. Growing seedlings in raised beds resulted high percentage of mortality and poor root and shoot growth development in main field due to transplanting shock. But in protray nursery, the seedlings are raised in protrays under net house with insect proof netting making use of coco peat media treated with Pseudomonas and Trichoderma. Each and every seedling is placed in different cell and provided with uniform nutrient and moisture resulted in uniform seedlings with similar physical and physiological age thus ensuring 100 per cent field stand and sustain 100 percent productive plants. The root mass is on the outer surface of root ball and hence there is no casualty.

Community Nursery

Instead of individual farmers raising small nursery for small holdings, they can jointly raise community nursery to produce healthy and uniform seedlings under net house suitable for different seasons and market demand. One shade net house nursery is recommended for every 20 hectares.

Portrays Nursery

Seedlings are grown in cells of portrays under shade net house with fully digested coco peat media treated with Pseudomonas and Trichoderma for best moisture conservation as well as good drainage. EC and pH of the media should be adjusted. The Cabbage and Cauliflower seedlings are extremely sensitive to EC and pH of the media while Chilli and Brinjal hybrid seedlings are hardy.

Shade Net

Ideal environment can be provided with shade net for seedlings growth. Shade net filtered the sunlight and hot and humid condition favours the seedlings growth in the portray. Shade net with 50% sunlight is suitable for portray nursery in plains and 30% is for hills. A quality seedling should be uniform vigour having six leaves. Hence providing nutritious media, optimum sunlight, uniform spacing, nutrient and water is essential to produce quality seedlings. Shade net house should be covered with nylon net to prevent entry of insects and pathogens.

Protrays

When seedlings are grown in raised bed, seedlings are affected by soil borne diseases resulting in poor root growth due to soil compaction. But seedlings are grown in protrays ensured good quality seedlings due to proper drainage and uniform spacing. Portrays are available with 0.2, 0.4, 0.6, 0.8- and 1.0-mm thickness and 1 inch and 1.5-inch width cells. Generally, for vegetables, 0.8 mm thickness with 98 cells is suitable. Portrays should have two holes at the bottom for draining excess water.

Coirpith Compost

Fully digested coirpith compost commercially available as coco peat (EC and pH adjusted) is used as media for protray. Vermicompost, Perlite and peat mass can also be used. But coirpith compost is economically viable for vegetable seedling production. Neutralized fully digested coirpith compost should be sterilized with hot water steam (or) formalin 0.5% to kill the soil borne pathogens. Digested coirpith compost favours good drainage for excess water as well as conserves the soil moisture during deficit period and promotes root growth.

Sowing

Selected vegetable hybrid seeds are treated with *Bacillus spp*. or *Trichoderma viride*. Protrays are filled with coco peat and holes are made with the depth of 1.2 cm. Seeds are sown at the rate of one seed per hole and covered with coco peat. Protrays are kept under polythene cover in darkness for 5 days for inducing uniform germination. After germination, protrays are kept in shade net house. Watering should be done twice a day by using rose cane. Shade net ensures 100% moisture in protrays and temperature around 20-30o C. But during summer temperature should not exceed 30oC. Protected shade net house is free from pest and diseases. Drenching of COC @ 1g/litre will control the damping off disease. Spraying of Imidochloprid @ 0.5 ml/litre (or) triazophos 0.5ml/litre will prevent the sucking pests.

Nutrition

Generally nitrogenous fertilizer viz., fish powder, oil and vermiwash are given as foliar spray. Sea weed contains more amount of growth regulators and micronutrients are the best foliar spray for nursery. The concentration of water-soluble fertilizers is maintained from 75 to100 ppm as foliar spray at early stages of nursery.

Transplanting Stage

Vegetables seedlings are ready for transplanting from 25 to 40 days after sowing. The growth of seedlings is more during summer than in winter season. But temperature more than 30o C will affect the seedlings growth. Fully grown seedlings with portray can be easily transported without any damage. One day before transplanting, watering is facilitated for easy uprooting of seedlings.

Advantages of Portrays Nursery

1. 95% field withstand after transplanting
2. Off season seedling production
3. Free from pest and diseases.
4. 90 – 100% yield assured due to uinform and healthy root system and no transplanting sock.
5. Less seed rate which reduces cost of the seed.

Conclusion

The advent of different nursery growing techniques has opened new vistas for growing vegetable crops in any month of the year irrespective of any vegetable crop. Such innovative techniques are facilitating the growers in producing offseason vegetables for fetching remunerative prices.

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Climate Change and Soil Organic Carbon Dynamics

Article ID: 40746

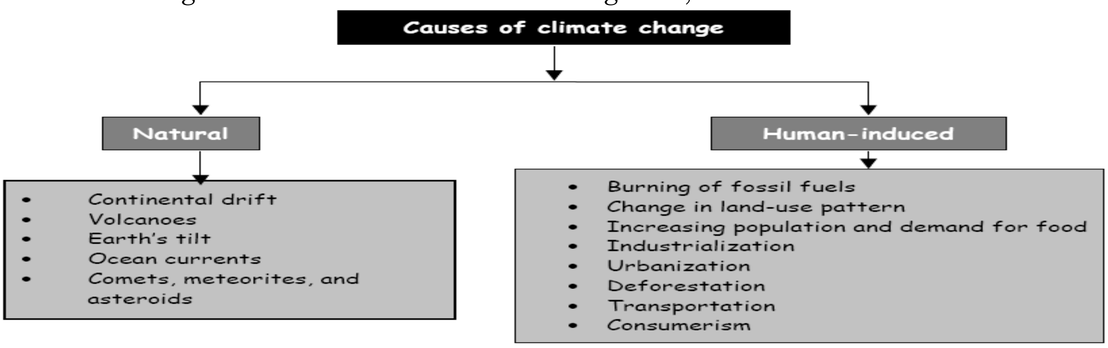
Nongmaithem Leindah Devi[1], Jotish Nongthombam[2], Santosh Kumar[2]
[1]Postdoctoral Scholar, K.V.K. CVSc & AH, CAU, Selesih, Aizawl, Mizoram
[2]K.V.K. CVSc & AH, CAU, Selesih, Aizawl, Mizoram

Introduction

Climate change is a long-term shift in the statistics of the weather (including its averages). It also refers as statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer).Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use.

Community Nursery

The causes of climate change can be divided in to two categories, human and natural causes.



Effect of Global Warming on Agriculture

Climate change could influence agricultural production adversely due to resulting:

1. Geographical shifts and yield changes in agriculture,
2. Reduction in the quantity of water available for irrigation
3. Loss of land through sea level rise and associated salinization.
4. Changes in temperature as well as changes in rainfall patterns and the increase in CO_2 levels.

Soil Carbon or Soil Organic Carbon (SOC)

Soil carbon, or soil organic carbon (SOC) is the carbon stored within soil. Soil organic carbon (SOC) is simultaneously a source, sink for nutrients and plays a vital role in soil fertility maintenance. It is part of the soil organic matter (SOM), which includes other important elements such as calcium, hydrogen, oxygen, and nitrogen. Soil organic matter is made up of plant and animal materials in various stages of decay. Un-decomposed materials on the surface of the soil, such as leaf litter, are not part of the organic matter until they start to decompose.

Importance of Soil Organic Carbon

1. Crop residues: Readily broken down and provide energy to soil biological processes

2. Particulate organic carbon:

a. Broken down relatively quickly but more slowly than crop residues.
b. Important for soil structure, energy for biological processes and provision of nutrients.

3. Humus:

a. Plays a role in all key soil functions
b. Particularly important in the provision of nutrients - for example the majority of available soil nitrogen derived from soil organic matter comes from the humus fraction.

4. Recalcitrant organic carbon:

a. Is usually charcoal - a product of burning carbon-rich materials. As 'biochar', it is attracting interest as both a carbon sink and, possibly, a source of soil benefits.

a. Decomposes very slowly and is therefore unavailable for use by micro-organisms.

Soil Organic Carbon Dynamics

Soil organic carbon dynamics is a dynamic between the litter decomposition with the increase or decrease in temperature by the action of microbial activity. It is mostly based on the litter decomposition, temperature and microbial activity.

Influence of Climatic Variables on Soil Organic Carbon Dynamics

1. It greatly control the biotic controls
2. It influence soil minerals
3. It disturb the ecosystem.

Climate Change Affect Soil Organic Carbon Dynamics

1. It doubles the rate of CO_2
2. It increase the global C reserves in soils
3. It increase the decomposition rate

Climate change poses a global challenge and India must play a dual role in responding to the challenge as a responsible member of the international community and in its own interest. There are two dimensions in the response to global warming- mitigation and adaptation.

Mitigation

Mitigation refers to efforts to reduce or prevent emission of greenhouse gases. Some of the measures for migration of climate change are as follows:

1. Reducing the future GHGs emissions
2. New species/ varieties
3. Germplasms
4. New farm management practices
5. Change in land use
6. Water harvesting and conservation
7. Improved low-impact harvesting in forests
8. Efficient use of energy resources.

Adaptation

Adaptation refers to the ability of a system to adjust to climate change in order to reduce its vulnerability, and enhance the resilience to observed and anticipated impacts of climate change. Adaptation occurs in physical, ecological, and human systems. It involves the following.

1. Changes in social and environmental processes
2. Perceptions of climate risk
3. Practices and functions to reduce risk
4. Exploration of new opportunities to cope with the changed environment

In other words, adaptation can be understood as an ongoing process addressing many factors and stresses, rather than just climate change in specific.

Conclusion

Climatic change requires a good scientific understanding as well as coordinated action at national and global level. Carbon sequestration via agricultural soils has the potential to contribute significantly to climate change mitigation, provided that specific measures are implemented. C sequestration could be increased by the adoption of improved agronomic practices.

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Aflatoxin: One of the Major Threats to Human Health

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S. A. Shendekar[1], M. R. Meshram[1], D. P. Gadpayale[2]
[1]PhD Scholar, Department of Agril. Botany, Post Graduate Institute, MPKV, Rahuri MS-413722.
[2]PhD Scholar, Division of Biochemistry, ICAR-IARI, New Delhi-110012.

What if Aflatoxin?

Aflatoxins are one of the highly toxic secondary metabolites produced by fungal species such as *Aspergillus flavus, Aspergillus parasiticus* and *Aspergillus nominus.* There are four main types of aflatoxins such as aflatoxin B_1, B_2, G_1 and G_2. They are classified based on type of light they emit under fluorescence. Among these four types of aflatoxins, aflatoxin B_1 is highly toxic.

Historical Background of Aflatoxin

In the spring of 1960, a new "disease" of turkeys was encountered in England because of which more than 100,000 turkeys died and the disease named as "Turkey X disease". In the search of identifying the reason for this, the researchers came to know that the groundnut meal imported from Brazil was highly contaminated with a toxin called "aflatoxin". A causal relationship between feed toxicity, Brazilian groundnut meal, and disease has been demonstrated by W.P. Blount, who accurately described the symptoms, especially liver lesions, and subsequently excluded that the disease could be the cause of the infectious agents.

Effect of Aflatoxin on Human Health

Aflatoxins are considered a Group 1 carcinogen according to the International Agency for Research on Cancer (IARC). Higher incidence of hepatocellular carcinomas is also tied into aflatoxin exposure in some countries. In addition, aflatoxin reduces immune response and increases susceptibility to disease, especially HIV. In 1974, a major outbreak of hepatitis due to aflatoxin was reported in India specifically in the states of Gujarat and Rajasthan, resulting in an estimated of 106 deaths. Approximately 4.5 billion people worldwide, mainly in developing countries, have been estimated to be chronically exposed to AFs via contaminated food.

Minimum Acceptable Limit of Aflatoxin

Different countries settled the maximum limit for aflatoxin in different food and feed products. U.S. Food and Drug Administration declared minimum aflatoxin concentration levels to be 0.5 µg/kg for milk products, 20 µg/kg for all other human food products, and even 300 µg/kg for cattle meal.

Crops Affected by Aflatoxin

Aspergillus mainly affects crop such as groundnut, wheat, maize and cotton.

Safety Measures to Prevent Aflatoxin Contamination

1. Don't eat aflatoxin affected food material.
2. Harvest produce at appropriate moisture content and dry it up to optimum moisture level. Store harvested produce in clean and dry place.
3. Use PICS bags for storage of agriculture produce.
4. Use biological control measure in field such as pre inoculation with non-toxigenic strains of *Aspergillus flavus* and *Aspergillus parasiticus*
5. Use mask while handling aflatoxin affected produce.
6. Maintain optimum moisture content in the field condition to reduce infestation.
7. Remove mold-damaged kernels, seeds or nuts from produce.
8. Seed treatment with Bacillus subtilis, Lactobacillus spp. and Pseudomonas species are effective at control and management of aflatoxins.

9. Good agricultural practices (GAPs) also help control the toxins to a larger extent, such as timely planting, providing adequate plant nutrition, controlling weeds, and crop rotation, which effectively control A. *flavus* infection in the field.
10. Maintain optimum moisture level in the field.

Fig: Aflatoxin infected maize and peanut produce

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Tomato Products - Processing Flow-Sheet for Tomato Chutney

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Dr. A. Nirmala[1], Dr. D. Rajani[2]
[1]Department of Horticulture, College of Agriculture, Hyderabad.
[2]Department of Horticulture, ACRIP, WIA, Hyderabad.
Professor Jayasankar Telangana State Agricultural University, Rajendranagar, Hyderabad.

TOMATOES (fully ripe, red)
⇩
WASHING
⇩
SORTING
⇩
BLANCHING FOR 2 MINUTES
⇩
PUTTING QUICKLY IN COLD WATER
⇩
PEELING
⇩
CRUSHING
⇩
ADDITION OF INGREDIENTS EXCEPT SALT AND VINEGAR AND COOKING GENTLY TO DESIRED CONSISTENCY
⇩
ADDITION OF SALT AND VINEGAR AND COOKING FOR 5 MINUTES
⇩
ADDITION OF PRESERVATIVE
⇩
FILLING HOT INTO BOTTLES
⇩
SEALING
⇩
STORAGE AT AMBIENT TEMPERATURE
(In cool and dry place)

Processing Flow-Sheet for Tomato Soup

TOMATO PULP/JUICE
(strained)
⇩
BOILING TO CONCENTRATE
⇩
PUTTING SPICE BAG IN COOKING PAN
(as in sauces)
⇩
PREPARING PASTE OF BUTTER AND FLOUR/STRACH

⇩

ADDITION TO CONCENTRATED JUICE

⇩

COOKING RO DESIRED CONSISTENCY WITH CONTINUOUS STIRRING
(to prevent coagulation of starch)

⇩

ADDITION OF SUGAR AND SALT AND COOKING
FOR 2 MINUTES

⇩

REMOVAL OF SPICE BAG
(after squeezing)

⇩

FILLING INTO CANS
(plain cans)

⇩

STERLIZATION
(at 115^{O}C for 40-45 minutes)

⇩

COOLING

⇩

STORAGE AT AMBIENT TEMPERATURE
(in cool and dry place)

Reference

Fruits and vegetable preservation principles and practices by R.P.Srivastatava and Sanjeev Kumar, 2006.

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Foxtail Millet: Nurturing Future through Biofortification

Article ID: 40749

Dr. Varsha Kumari[1]

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

Introduction

Biofortification of staple food crops is an economical and practical way to mitigate micronutrient malnutrition as it predisposes humans to different health maladies. Despite the availability of various methods for biofortification, the biofortified crops, especially millets, could offer a great scope. Foxtail millet has adequate content of minerals, non-starchy polysaccharides, vital amino acids, and proteins, and is regarded as one of the most important nutri-cereals. However, biofortified foxtail millet can potentially alleviate the micronutrient deficiency. Genetic modification to improve the micronutrient content through the available zinc and iron-regulated transporters in foxtail millet can be useful to fine tune the enrichment of micronutrients. The availability of well annotated foxtail millet genome sequence information can facilitate gene mining, transcripts and proteins related to nutritional quality. Combining the insights gained from proteomics, transcriptomics, genomics, and metabolomics might help foxtail millet to become a model system (Andersson *et al.* 2017).

Malnutrition, caused by vitamin A, iodine, and/or iron insufficiency, as well as zinc inadequacy, affects the human population including women and children in the world's poorest communities however, pregnant women and children under five years are at a higher risk. Considerable progress has been made to reduce the extent of malnutrition, but the deficiencies continue to impinge on the health of women and children. Several sustainable food production strategies and nutri-crop systems are being developed to manage nutritional security in developing countries. The four major staple crops that meet food security are rice, wheat, maize and barley, however biofortified crops such as millets are thought to significantly contribute to nutritional security. Millets are mainly produced in the central regions of Africa and Asia.

Importance of Foxtail Millet

Foxtail millet is extensively used as an energy source for the children, diabetic patients and pregnant and nursing women. Health benefits are represented by its effects in reducing serum lipids, blood glucose and glycosylated hemoglobin in patients with type 2 diabetes. The mineral content of foxtail millet ranges from 1.7 to 4.3 g/100 g dry weight. The calcium, iron, phosphorus, and zinc concentrations in foxtail millet are 31, 3.5, 300 and 60.6 mg/100 g dry weight, respectively. Thiamine, niacin and riboflavin are present in foxtail millet and their concentration is 0.60, 0.55, 1.65 mg/100 dry weight, respectively. A higher concentration of vitamins and minerals than other cereals makes foxtail millet an easy and cheap substitute to tackle nutritional adversity. Besides macro and micronutrients, foxtail millet possesses important phenolic acids, flavonoids, and tannins, known for their antioxidant, anti-mutagenic, antiviral, and anti-inflammatory effects (Alagarasan *et al*., 2017).

Micronutrients and Biofortification

Micronutrients are mainly composed of vitamins and minerals and they are vital for human growth and development. It is estimated that malnutrition-associated mortality in children accounts for 3.1 million deaths, of which 1.1 million are due to micronutrient deficiencies. The percentage of population with selected micronutrient deficiencies is represented. The deficiency of micronutrients results in serious illness, weakened immune system, malnutrition and underdevelopment. This problem has been identified as a serious and increasing problem in both developing and underdeveloped countries. One of the key causes impacting children, premenopausal women, and adults in low- and middle-income nations is iron deficiency anemia. Iron, folate and vitamin B_{12} deficiency results in anemia while there is also coassociation of the deficiency with other ailments such as lower learning ability, memory and neuropsychological behavior among children. Iron also plays a crucial function in hemoglobin, myoglobin, enzymes, and cytochromes and is necessary for oxygen transport and cellular respiration. Unlike iron, zinc does not experience a decline in blood levels in the event of a severe deficiency. Children often have a severe type of zinc deficiency. The diets of people in South Asia, South East Asia, and Africa appear to contain relatively little zinc. As zinc interacts with 925 proteins in humans, the symptoms of zinc deficiency may be multiple and indiscriminate, which makes it extremely difficult to diagnose in humans. Deficiency of Vitamin A is associated with childhood mortality and morbidity in the developing nations, particularly in Africa and Southeast Asia.

Foxtail Millet and Biofortification

The potential for biofortification of foxtail millet is immense and it can be achieved through conventional breeding, genetic modification and agronomic approaches for increasing the nutrient level in the grains or by increasing the availability of the nutrients by decreasing the anti-nutrient content. Agronomic methods that apply various minerals as fertilizers are not regarded economical as they require additional costs and management. In foxtail millet, scientist evaluated the foliar spraying of sodium selenite (Na_2SeO_3), which led to a 9.8-fold rise in selenomethionine and selenocysteine with a concurrent increase in potassium and iron content. The findings suggest that foxtail millet has Se-inducible proteins that may prove valuable in Se-enriched millets. Nanoscale biofortification and supplementation with numerous micronutrients are advised for biofortifying Se in millets. If the desirable trait is not available in the germplasm, genetic modification technology is used to introduce desirable traits from different plant or non-plant sources. The advantages of this method are that multiple genes of interest can be incorporated and targeted expression in tissues can be achieved. More recently, engineering of membrane bound nutrient transporters has been viewed to play a key role in the biofortification of crops. Foxtail millet has desirable attributes of drought tolerance, pest resistance and the crop are enriched with micro and macronutrients. The development of a successful core collection depends on the proper sampling of phenotypic associations which are linked to the co-adaption of gene complexes. In this regard, phenotypic correlations are important for initial characterization by trait identification. Molecular and morphological markers have been used to identify genetic variability for nutritional traits in foxtail millet. Microsatellites, known as simple sequence repeats or SSRs, are responsible for maintaining their high number of polymorphism and high variation levels. Molecular evaluation of 30 foxtail millet accessions, led to exploring of untapped genetic diversity of foxtail millet in the Himalayan region for variability in nutritional traits such as dietary fiber, starch, protein and amino acid content. In the Indian context, there are also new biofortified varieties (SiA 3088: 129 ppm, SiA 3142 & TNAU-186) developed for high iron (> 129ppm) which have shown promise for use in the HarvestPlus program. High iron foxtail millet varieties can find greater utility in the biofortification programs for alleviating iron deficiency among the preschool children, non- pregnant, non-lactating women of reproductive age (Angers *et al*., 2006) Figure 1.

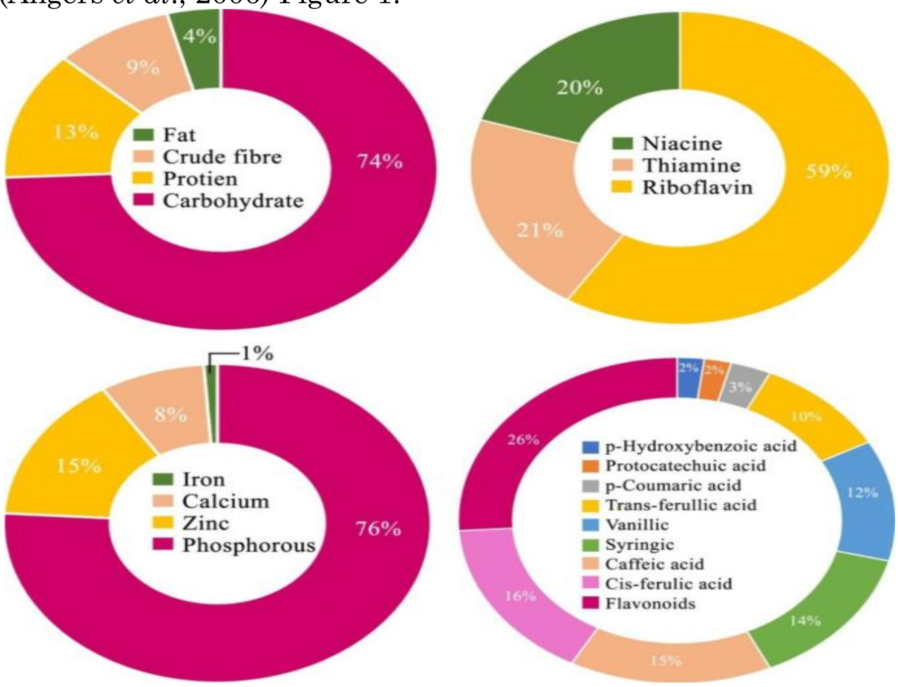

Figure 1: Diagrammatic representation of the nutritive value of foxtail millet.

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Genomic Selection for Crop Improvement

Article ID: 40750

S. A. Shendekar[1], M. R. Meshram[1], D. P. Gadpayale[2]
[1]PhD Scholar, Department of Agril. Botany, Post Graduate Institute, MPKV, Rahuri MS-413722
[2]PhD Scholar, Division of Biochemistry, ICAR-IARI, New Delhi-110012.

Introduction

Producing sufficient food to meet the demand of vastly growing population and eradication of rural poverty is one of the critically important issues that the world is facing. At the current pace, the world population is expected to cross the mark of nine billion people by 2050 adding further pressure to already exhausted food production systems. So, this necessitates the genetic improvement of crop cultivars through plant breeding for global food security. However, the current rates of yield improvements are insufficient to meet this goal. Requirement of up to 70% more plant-based products by the middle of this century in order to meet the rapidly growing demand can be achieved only by reshaping the current breeding programs (Tester and Langridge, 2010).

Development of crop varieties using conventional breeding approaches has been effective but time-consuming and labour-intensive. Initially markers were integrated with phenotypic selection by applying Marker Assisted Selection (MAS). However, it failed to improve complex traits governed by Quantitative Trait Loci (QTLs) having small effects. To overcome the limitation of marker assisted selection, association mapping was started in 2000s. This scheme requires marker with high association with the trait of interest and this in turn limits the number of markers being used in the breeding program. Genomic Selection (GS) proved to be a novel approach to overcome the above discussed limits of different breeding schemes as it uses all molecular markers for genomic enabled prediction of the performance of the candidates for selection. Genomic Selection (GS) is a novel breeding method that incorporates all the available marker information into a model to predict genetic values of breeding progenies for selection (Beyene *et al*., 2015).

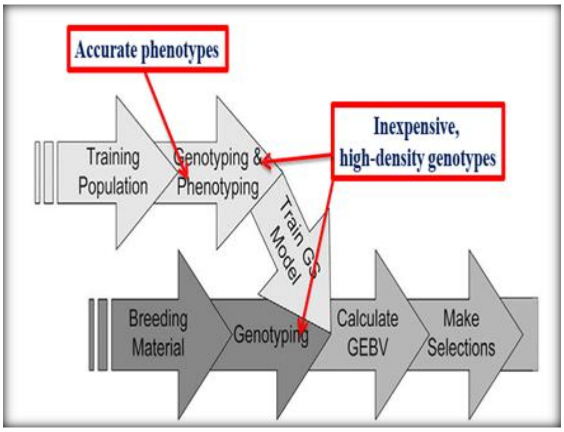
Genomic Selection (GS)

GS is a specialized form of MAS, in which information from genotype data on marker alleles covering the entire genome forms the basis of selection. Thus, the effects associated with all the marker loci, irrespective of whether the effects are significant or not, covering the entire genome are estimated. The marker effect estimates are used to calculate the genomic estimated breeding values (GEBVs) of different individuals/lines, which form the basis of selection. The GEBV of an individual is the sum total of effects associated with all the marker alleles present in the individual and included in the GS model applied to the population under selection.

Procedure for Genomic Selection

1. The first step in a GS program is to create a training population suitable for the concerned breeding population.
2. The individuals/lines in the training population are genotyped for a large number of markers evenly distributed over the entire genome at adequate density.
3. The individuals/lines in the training population are subjected to extensive phenotypic evaluation for the target trait(s) in replicated trials over locations and preferably years.
4. The phenotype and marker genotype data are used for computing the GS model parameters; this is called model training. Model training can be performed repeatedly to include data on new markers and additional traits. The estimates of GS model parameters are retained for subsequent application to the breeding population.
5. The breeding population is evaluated for the same set of markers that was used for estimation of the model parameters in the training population. There is no phenotypic evaluation of the breeding population.
6. The GEBVs of individuals/lines of the breeding population are calculated from their marker genotype data and the marker associated effects estimated from the training population.

7. The superior individuals/lines are selected from the breeding population on the basis of their GEBV estimates.



Advantage of GS Over Traditional Methods and MAS

Over the years, the application of GS in crop plants and tree species has been recognized owing to its great potential for enhanced breeding. Basically, GS is a form of MAS with extended scope and advantages. GS involves estimation of effects of several genome wide markers, at the same time, to compute the genetic values, i.e., genomic estimated breeding value (GEBV) of the untested populations instead of only a subset of markers used for selection as in case of MAS.

In MAS, prior identification and mapping of genes or QTLs related to the traits of interest, estimations of marker-trait associations and their validation in different populations is required. Further, it explains only a limited part of the genetic variations for a trait, i.e., QTLs with small effects would not be detected. In contrast, GS eliminates the need for mapping of genes/QTLs associated with traits and instead follows a black-box approach involving the use of genome wide markers and is capable of identifying all the QTLs, including those with small effects that are missed by MAS. As per the principle of GS, genome wide markers are used to capture all possible genetic variations in the population and each QTL governing a trait is in linkage disequilibrium (LD) with at least one marker. The accuracy of GS relies on LD between specific alleles of markers and QTL; the stronger the LD between the two, the greater is the accuracy of genomic predictions.

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Role of Crop Rotation in Indian Agriculture

Article ID: 40751

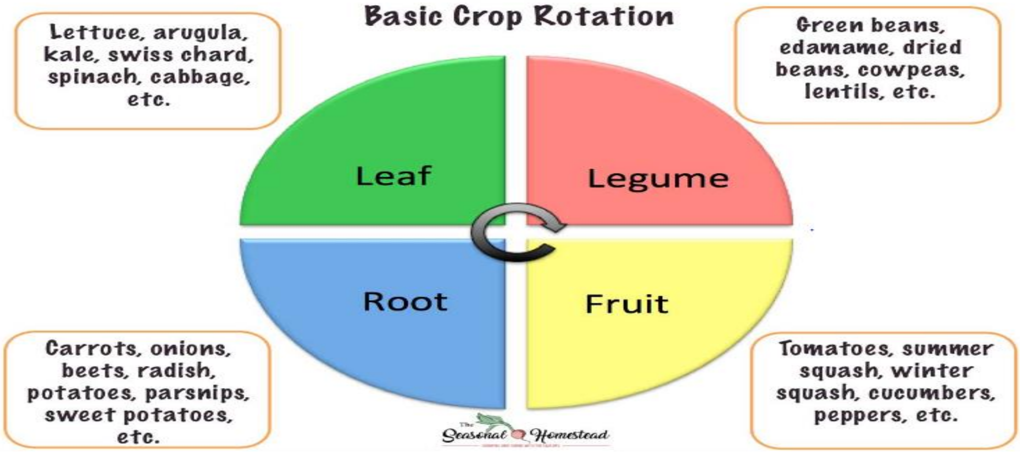
Rahul Dhankar[1], Sushil Kumar Singh[2], Anjali Tomar[3]
[1]Assistant Professor, Shri Vishwakarma Skill University, Palwal, Haryana.
[2]Assistant Scientist, CCS Haryana Agriculture University, Hisar, Haryana.
[3]Ph.D. Scholar, Department of Agriculture Extension and Communication, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh.

Crop Rotation

The process of growing different crops in succession on the same piece of land chiefly to conserve the production capacity of the soil. Main reasons to do crop rotation is to improve soil health, optimize nutrients in the soil, and combat pest and weed pressure.

Crop rotation systems and cropping patterns depend on soil type, depending on the availability and quality of irrigation water and other available means. On heavy soils, farmers usually grow cotton in the first year and jowar in the second year. In the third year, fallow is done during the caripa season and wheat is planted during the rabi season. A good crop rotation requires long-term strategic planning. However, planning does not necessarily include determining which crops will be grown on the site in the coming years. Indeed, such specificity may prove futile as plans become disrupted by weather, changes in the market, labor supply, and other factors. Lack of planning, however, can lead to serious problems—for example, the buildup of a soil borne disease of a critical crop, or imbalances in soil nutrients. Such problems can result in an inability to meet the demands of a carefully cultivated market or in additional labor and expense. Problems caused by faulty rotation often take several years to develop and can catch even experienced growers by surprise. In fact, rotation problems usually do not develop until well after the transition to organic cropping. Since the crops grown by organic farmers are often different and more diverse than those grown in the preceding conventional system, the organic transition itself often rotates away from the previous crops and their associated problems. Most farmers are greatly tempted to plant excessive acreage of the most profitable crop or to overuse certain fields for one type of crop. Such practices can lead to costly problems that take many years to correct. The purpose of this book is to help growers and farm advisors understand the management of crop rotations; avoid crop rotation problems; and use crop rotation to build better soil, control pests, and develop profitable farms that support satisfied families (Charleset al.,2009).

1. Planting crops on parts or areas of soil in a sequence that does not reduce soil fertility at any given time is called crop rotation.
2. Growing crops on land over a period of time in a preplanned sequence is called a crop rotation.
3. Re-cultivation or sowing on specific plots of land and then tilling the plots in a specific sequence is called a crop rotation pattern
4. Simply put, in crop rotation, the land is fixed, but crops are rotated from year to year on the same land in a sequence that maintains soil fertility.



Principles of Crop Rotation

1. Main root crops should be followed by fibrous root crops. This contributes to the correct and uniform use of nutrients from the soil.
2. Legumes should be grown after non-legumes. Legumes fix atmospheric nitrogen in the soil and add more organic matter to the soil.
3. If there are many depleting crops, less depleting crops must follow.
4. Crops of the same family should not be grown sequentially as they serve as alternate hosts for pests and diseases.
5. An ideal crop rotation is one that ensures maximum family employment, agricultural labor, and efficient use of agricultural machinery and equipment.
6. Crop selection should be based on demand.
7. Culture selection should be problem-based.
8. Crop selection must match the farmer's financial situation.
9. The crops chosen must also be suitable for soil and climatic conditions.

Benefits of Crop Rotation

1. Beneficial to succeeding crops.
2. Soil fertility is restored by fixing atmospheric nitrogen.
3. Encourages soil microbial activity.
4. Improves physico-chemical properties of the soil.
5. Avoids accumulation of toxins (HCN etc.).
6. Soil is protected from erosion.
7. Controls pests and diseases.
8. Controls weeds in the fields.
9. The family and farm labour, power, equipment and machineries are well employed.
10. Differential extraction of nutrients and moisture from different depths.
11. Proper utilization of all the resources and inputs.

Limitations of Crop Rotation

1. Specialization in one crop is not possible.
2. Requirement of equipments and machineries varies from crop to crop.
3. Allopathic effect of preceding crop.

Analyze Data and Plan Crop Rotation

All decisions and information derived from previous tasks and responsibilities are gathered for analysis at this key stage in the planning process. Data on market options, equipment, labor and seed availability are analyzed along with financial constraints, overall farm and crop rotation goals. Information is cross-referenced and weighted where necessary. Possible compromises are being considered. For example, a field team can seed two fields with high-value crops, but cannot harvest early in the same week. Compare the cultural needs of crops with the characteristics and conditions of each field. Specialists evaluate the condition of the soil and decide how to deal with pests (animals, insects, weeds) and diseases from the previous season. This is one of the most difficult tasks. Weather forecasts are also taken into account. All possible culture mixtures are analyzed. This responsibility is the final synthesis of information and leads to production planning and turnover planning. Experienced farmers differentiate between these two types of planning. A production plan defines what should be grown (crop mix) and how it is grown, while a crop rotation plan defines where each crop is to be planted. Final decisions about crop composition and distribution of crops to fields and from fields to crops are critical to this responsibility. Information such as which crops to grow and how much to grow, seasonal labor availability, equipment required, and desired harvest dates are incorporated into crop rotation plans for each field and for the entire farm. Two questions go back and forth. First, what will be grown in each field? Another question is where each crop will grow. The answers to these questions are based on observation and experience. Several steps are required. First, analyze the crop history of each field or bed over the past 3 years or more. This includes cultivated crops and crop groups. how well they performed; certain successes or failures; Logistical issues related to equipment use, irrigation, harvesting or labor. Obviously, the size of the field and the needs of the market (how much each crop needs) are also taken into account. The distribution of crops to fields includes consideration of the field's planting history as well as future planting plans. Crop rotation plans should take into account weed pressure or other legacies of the past year and provide favorable conditions for future crops. An experienced farmer will first assign the highest priority crops to the field (or nursery). High-priority crops include the most profitable crops, the most profitable cover crops, and crops that are particularly vulnerable to pests, diseases, or weather. Decisions are also based on high-priority fields, such as the highest fertility fields, the best places to harvest, or whether there are current issues that need to be addressed. Remaining fields (or portions of fields) are turned over to leftover crops, cover crops, fallow land, and sometimes pasture for livestock. All of these decisions are based on business and biology. Crops and fields are linked in advance to create a harvest plan for the entire farm for the year. Many professionals record this information on farm maps and notebooks. They take this initial plan and, in the words of one of them, "work it out in their heads." This means that each crop and field performs a series of field tasks throughout the season, from plowing to harvesting. Several experienced farmers plan on-site and roam the farm for this operation. They take into account why either sequence might not work, considering when it works or possible logistical or biological conflicts, such as the spread of pests between adjacent crops. Then adjust the plan as needed (Johnson and Toensmeier, 2009).

Crop Rotation Examples

Year one:

Section one: Potatoes
Section two: Legumes, onions and roots
Section three: Brassicas

Year two:

Section one: Legumes, onions and roots
Section two: Brassicas
Section three: Potatoes

Year three:

Section one: Brassicas
Section two: Potatoes
Section three: Legumes, onions and roots.

Conclusion

Traditional crop rotation is generally exhausting and contributes nothing to soil fertility. The fundamental problem is thus to devise a crop rotation that will increase soil fertility, allowing the following crop to fully benefit from the favourable moisture requirements prevailing during its growing periods. The basic principle behind crop rotation is that different crops shouldn't be produced on the same land year after year. Crop rotation systems have several advantages, but the way they operate varies from one region to another.

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Importance and Approaches of Sustainable Agriculture

Article ID: 40752

Mo Naushad[1], Nivedita Prasad[2]
[1]M.Sc. Scholar, Department of Agronomy, United University, Jhalwa, Prayagraj (U.P.)
[2]Assistant Professor, Department of Agriculture & Allied Sciences, United University, Jhalwa, Prayagraj (U.P.)

Introduction

Over the past few decades, our ecosystem and, consequently, our biosphere have come under increasing scrutiny. This has prompted us to consider, invent, and use alternative techniques or smaller-scale efforts to preserve our ecosystem. Sustainable gardening is just one of these efforts. It essentially refers to the creation of food, plants, and animal goods using farming methods that support fiscal viability and the general welfare. It is inspired by organic gardening and learns from it. In addition to the usual benefits of farming, sustainable farming or sustainable agriculture encourages producers to develop and use recycling techniques. Crop refuse or livestock excrement would be excellent examples of recycling in sustainable farming. The same can be changed into fertilizers that will help the earth get better.

Two major social concerns must be taken into account on the road to sustainable agriculture: protecting the ecosystem and ensuring access to nutritious food for all. To discover a shared route towards a sustainable future, these priorities are both interconnected and crucial. Sustainability is a systems problem and is defined as the capacity to endure. A system is a collection of various elements, components, subsystems, or parts knit together into an integrated whole that aids in the organization of the system and the upkeep of its coherence. Sustainability as an objective desires permanence for an activity or a system (Von Bertalanffy, 1968). Because its components engage with one another, a sustainable system is one that endures new pressures and disturbances (Costanza and Palten, 1995). A sustainable system is one that achieves its anticipated life span in accordance with temporal and geographic scale, not one that has an endless life span.

Importance of Sustainable Agriculture

Sustainable agriculture frequently encompasses a wide range of production practices, including conventional and organic. A regionally integrated system of plant and animal production practices are designed to produce long-term results such as:

1. Production of sufficient human food, feed, fiber, and fuel to meet the needs of a sharply rising population
2. Protection of the environment and expansion of the natural resources supply
3. Sustainment of the economic viability of agriculture systems
4. Make the most efficient use of non-renewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls
5. Enhance the quality of life for farmers and society as a whole.

Why Sustainable Agriculture is Important?

The populace of the globe is expanding quickly. Asian nations have populations that are stated in billions, and it is predicted that populations in Europe and the Americas will soon reach billions. There will undoubtedly be a significant future need for sustenance as a result of this. Making sure that everyone has access to basic requirements in the present and the future is one of industrial agriculture's primary goals. Industrial agriculture uses more chemicals to produce more food on the one hand while polluting land resources and farming resources with chemical residues and reducing output potential on the other. This actually contradicts itself. Currently, the sustainable farming approach guarantees output and long-term agricultural production while safeguarding the soil and the ecosystem. In summary, the benefits of sustainable agriculture are as follows:

1. With sustainable agriculture method, it is possible to produce more than one product in small areas and high efficiency.

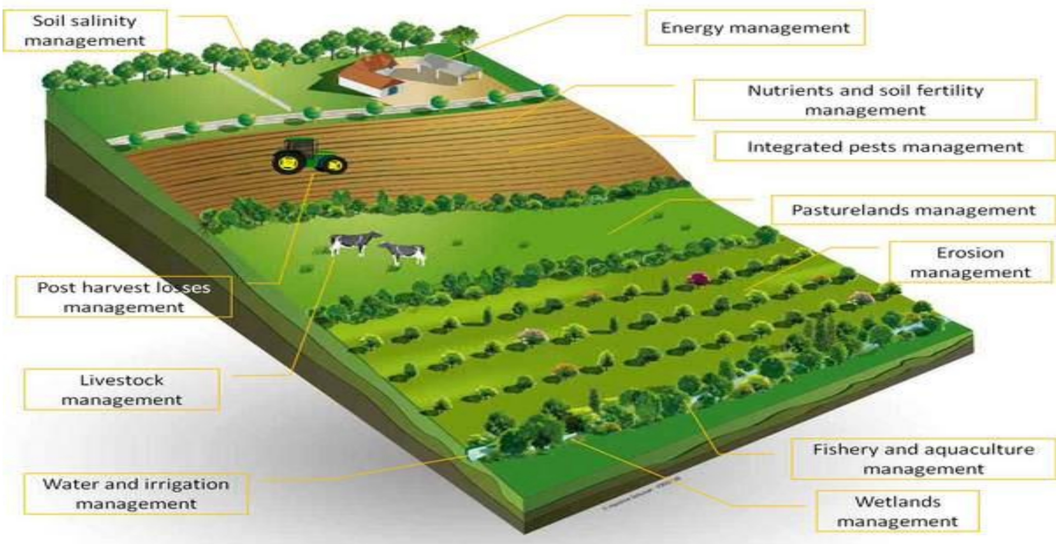
2. An enterprise with sustainability will have a positive impact on the ecosystem. Efficient soils will have a habitat for animals, but will also contribute to agricultural production.
3. The fertilization of the soil will ensure long-term use and increase of productivity.
4. In addition to the benefits to agriculture, contributes to the creation of new areas of employment.

General Principles of Sustainable Agriculture

Some general principles of sustainable agriculture can be listed as follows:
1. Soil must be protected and developed: Soil is absolutely necessary for good and healthy products. Soil should be enriched with natural fertilizers such as organic and green manure and compost. Natural fertilizers are healthier for soil, plants, water, air and people than chemical fertilizers.

2. Water and water resources should be protected: Agriculture requires only pure water, just like in real life. Growing plants that are appropriate for the local ecosystem or that only require water during the wet season is the best method to preserve water in arid areas. Mulch and green fertilizer are effective at retaining moisture in the earth. By obstructing water movement, the contour obstacles safeguard the water. Applying trickle irrigation in place of conventional irrigation techniques and scheduling watering times are two additional methods for conserving water.

3. To control pests and diseases naturally: To balance nature, goods, pests, diseases, vegetation, and dirt, natural or integrated security management should be used instead of chemical control. Techniques like selecting hardy types, maintaining the right spacing between plants during sowing, properly timing farming practices, utilizing natural predators, and crop rotation are crucial in this respect for the success of the approach.



What is Agricultural Sustainability?

Many different terms have come to be used to imply greater sustainability in some agricultural systems over prevailing ones (both pre-industrial and industrialized). These include sustainable, eco-agriculture, permaculture, organic, ecological, low-input, biodynamic, environmentally-sensitive, community-based, wise-use, farm-fresh and extensive. There is continuing and intense debate about whether agricultural systems using some of these terms qualify as sustainable.
Systems high in sustainability are making the best use of nature's goods and services whilst not damaging these assets. The principles are to:
1. Integrate natural processes such as nutrient cycling, nitrogen fixation, soil regeneration and natural enemies of pests into food production processes;
2. Minimize the use of non-renewable inputs that damage the environment or harm the health of farmers and consumers;
3. Make productive use of the knowledge and skills of farmers, so improving their self-reliance and substituting human capital for costly inputs;
4. Make productive use of people's capacities to work together to solve common agricultural and natural resource problems, such as for pest, watershed, irrigation, forest and credit management.

Approaches of Sustainable Agriculture

1. Permaculture- A food production system using permaculture reduces resource waste and increases production effectiveness through design, planning, and wise farming. The emphasis is on using perennial plants like fruit trees, nut trees, and shrubs that work together in a system that was intended to replicate how plants in a natural environment would work.

2. Permaculture design techniques include growing grain without tillage, herb and plant spirals, keyhole and mandala gardens, sheet mulching, each plant serving multiple purposes, and creating swales on contour to hold water high on the landscape.

3. Biodynamic Farming- Biodynamic incorporates ecological and holistic growing practices based on the philosophy of "anthroposophy." Biodynamic practices can be applied to farms that grow a variety of produce, gardens, vineyards, and other forms of agriculture. In biodynamic farming, the high biodiversity of plants, animals and beneficial insects help replenish soil fertility and enhance plant growth to create a resilient ecosystem and support each other's health. Biodynamic focus on generating the necessary health and soil fertility for food production onsite through the implementation of practices such as composting, application of animal manure from farmed animals, cover cropping or rotating complementary crops.

4. Organic Farming- It applies to farm production methods that forbid the use of synthetic herbicides, fertilizers, or seed that have undergone genetic modification (GM). Organic producers use biological techniques and management practices in an effort to protect the ecosystem. One of them includes maintaining soil and water purity as well as using diverse agricultural rotations. Organic farming increases soil organic matter, which also improves the earth's ability to cycle nutrients and assimilate and store carbon. Organic soil material is more resistant to the effects of environmental stressors like drought and flooding.

5. Conservation agriculture- The concepts of minimum mechanical soil disturbance, constant soil cover with living or dead plant material, and crop diversity through rotation or intercropping form the foundation of conservation agriculture. In addition to rectifying land deterioration, safeguarding the environment, and addressing the rising challenges of climate change, it aids farmers in maintaining and boosting harvests and increasing earnings. Conservation agriculture preserves labor, wildlife, and natural resources. It increases the amount of water that is accessible for the soil, lessens the effects of heat and dryness, and improves soil health over time.

6. Zero-tillage farming, which permits direct sowing without ploughing or soil preparation, is a technique used by farmers to lessen soil disruption. The prior crop's surface residues are immediately seeded through.

7. Intercropping and crop rotation are coupled with zero tillage, which entails either growing two or more crops concurrently on the same plot of land or growing two separate crops sequentially on the same plot of land. These fundamental ideas underpin sustainable expansion as well.

8. Regenerative agriculture - This type of farming is improving the condition of the land. Creating a living earth rich in fungus, insects, and other microorganisms. The earth is home to one-third of the world's variety. Soil restoration is crucial for our ability to produce sustenance in the future. Genomes, cells, organisms, and environments become robust to natural changes or events that cause disruption or harm through the processes of renewal, restoration, and development.

9. Carbon farming- Although it is not the approach's primary objective, implementing carbon farming can assist in addressing other environmental effects associated with farmland, such as groundwater and surface water pollution. Another element is resource efficiency, though this one has the goal of lowering emissions. Composting manure and other refuse is resource-efficient, but it prevents the release of GHGs, especially methane.

10. Climate smart agriculture- A strategy for changing agricultural production systems and food value networks so that they promote sustainable development and can guarantee food security in the face of climate change is known as climate-smart agriculture (CSA). Climate-smart agriculture aids in reducing or eliminating greenhouse gas emissions, adapting to climate change, and increasing farming output and revenue in a sustainable manner. Neither the farming system nor the practices used in climate-smart agriculture are novel. It is an innovative approach for charting development pathways that can make the agriculture sectors more productive and sustainable and better able to contribute to climate change adaptation and mitigation.

Conclusion

As far as we are aware, organic farming was practiced for a long period until the green revolution, when conventional farming took its position. Our soil's vitality is decreasing daily as a result of the use of artificial fertilizers and pesticides. Once more, we are working towards steadiness in order to preserve soil fertility and create healthy soil using organic fertilizer. Wasted resources are recovered and utilized in sustainable agriculture to increase soil fertility and protect the ecosystem.

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Genetics & Plant Breeding - "Metabolomics Approach in Crop Improvement"

Article ID: 40753

Honnappa M[1], Padmashree R[1], Umesh Babu B S[2], Surekha S[1]
[1]Ph.D. Research Scholar, [2] Department of Genetics & Plant Breeding, [2] Raichur, Karnataka-584104.
[2]Assistant Professor (GPB)Agricultural Horticultural Research Station (AHRS) Ponnampet, Kodagu, Karntaka-571216.

Introduction

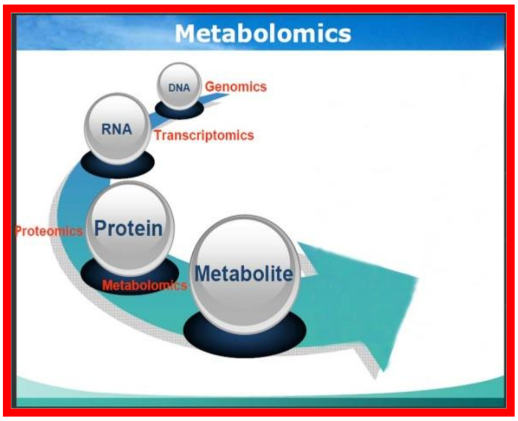
Modern plant breeding uses conventional breeding technologies and biotechnology to improve crop quality. Recent molecular technologies like SNP are successful only in case of monogenic traitor dominant genes and it has limited applications in case of polyploidy and epistatic ally or environmentally influenced traits. So, metabolomics represents an important addition to the tools currently employed in the genomics assisted crop improvement.

Metabolomics is one of the major disciplines in the so-called 'omics' field in plant, animal, and microbial sciences. Recent years have witnessed huge developments in different 'omics' fields, namely genomics, transcriptomics, epigenomics, proteomics, metabolomics and phenomics (Parry and Hawkesford, 2012; Kumar *et al.,* 2017). Among omics approaches, the metabolomics is the most complex and has received inadequate attention in cropscience, particularly for traitmapping and plant selections.In recent years, metabolomics has established itself as one of the major breakthroughs in science, paving the way for accurate metabolite profiling in microbes, plants and animals.

The output of plant metabolomics depends largely on its methodologies and instrumentations to comprehensively identify, quantify and localize every metabolite. Metabolomics is used to obtain a large amount of valuable information for the discovery of genes and pathways through accurate and high throughput corollary peak annotation via snapshotting the plant metabolome.

Terms in Metabolomics

Metabolites
Metabolome
Metabolomics
Metabonomics
Metabolic profiling
Metabolic fingerprinting

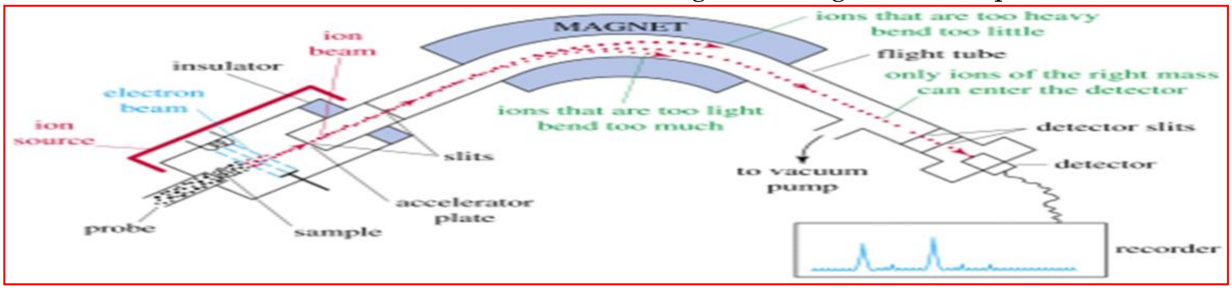


Metabolite Profiling Technologies

Mass Spectrometry:

a. It is an analytical technique that ionizes chemical species and sorts the ions based on their mass to charge ratio.

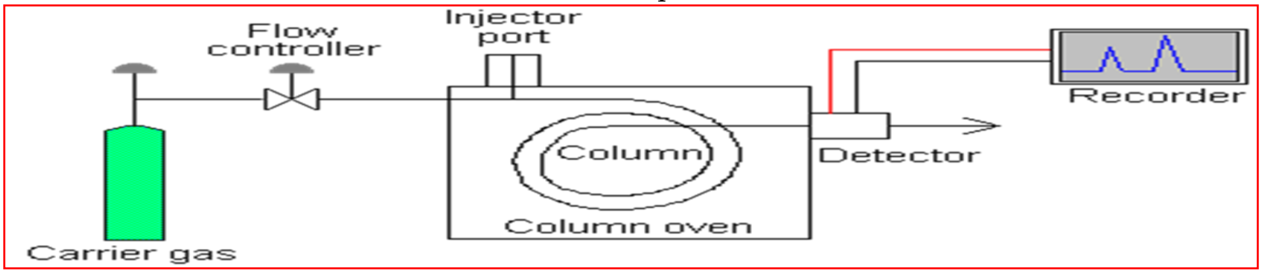
b. It allows the identification of metabolite according to its fragmentation pattern.



Gas Chromatography- Mass Spectrometry:

a. It separates the compound on the basis of their relative vapour pressure and the affinity of the material in chromatography column.

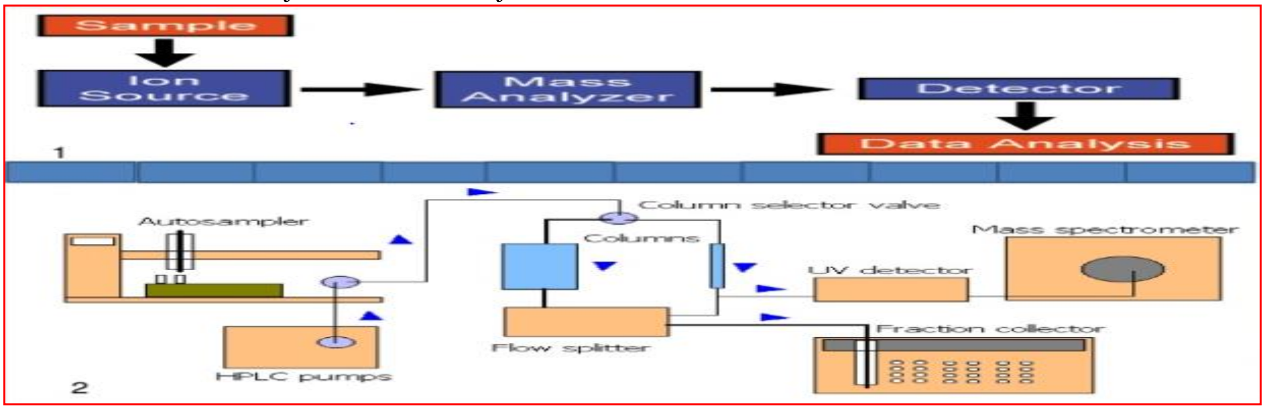
b. It is restricted to volatile and heat stable compounds.



Liquid Chromatography-Mass Spectrometry:

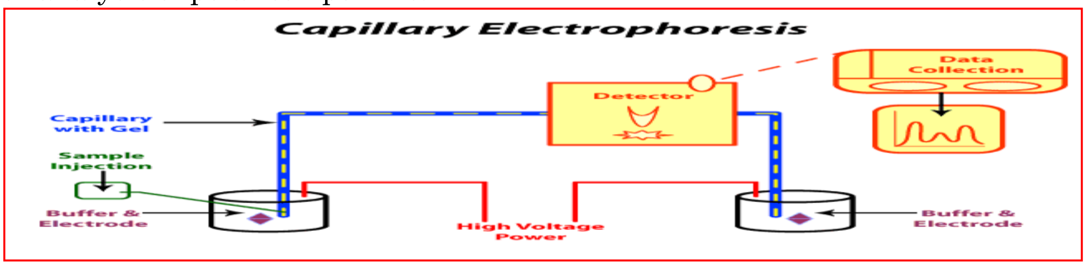
a. LC separates the mixtures with multiple components; MS component provides structural identity to the individual components, with high molecular specificity and detection sensitivity.

b. It is used for analysis of secondary metabolites.



Capillary Electrophoresis- Mass Spectrometry

1. It is the separation technique which uses high electric field to produce electro-osmotic flow for separation of ions. Analytes migrate from one end of capillary to other based on their charge, viscosity and size.
2. It is used for analysis of polar compounds.



Nuclear Magnetic Resonance (NMR) Spectroscopy

1. The sample is placed in a magnetic field and the NMR signal is produced by excitation of the nuclei sample with radio waves into Nuclear Magnetic resonance, which is detected through sensitive radio receivers.

2. It is a non-destructive approach and the samples can thus analysed in vivo.

Matrix Assisted Laser Desorption Ionization (MALDI)

1. It is an ionization technique that uses laser energy absorbing matrix to create ions from large molecules with minimal fragmentation.
2. It is used for analysis of biomolecules and large organic molecules.

Fourier-Transform Infrared Spectroscopy (FT-IR)

1. It is a technique used to obtain an infrared spectrum of absorption or emission of a solid, liquid or gas.
2. It collects high spectral resolution data over a wide spectral range.

Applications of Metabolomics

1. In Clinical analysis.
2. Metabolomics allows probing of rapid physiological changes or events that are not as easily detected by microarrays or proteomic approach.
3. Study of gene expression and environmental stresses.
4. To understand and to predict the behaviour of complex systems (such as plants) by using the results obtained from data mining tools.
5. To study growth & behavior of genetically altered plants, qualitative trait analysis, and systems biology.
6. For discovery and identification of markers of diseased and stressed plants, as well as following genetic modifications.
7. To study the genetic modifications as well as the influence of altered gene activity on the cellular composition of the plant.
8. With other '-omics' technologies can be utilized to estimate and assess the potential risks associated with transgenesis.
9. To compare the metabolic responses of commercially important crop species with those of closely related wild species characterized by higher tolerance levels to a particular stress condition.

Limitations of Metabolomics

1. Inability to comprehensively profile all of the metabolome.
2. Minor (low concentration) metabolites are difficult to measure but often of critical importance.
3. Controlling analytical variability is a problem with multi-analyte samples.
4. Biological variance is inherent in most living organisms.
5. Dynamic range of most instrumental approaches is insufficient.

Future Directions in Metabolomics

1. Modelling and simulation.
2. Improved comprehensive coverage of metabolome.
3. Reference material and facilitation of comparative result.
4. Integration of metabolomics with other functional genomics data.
5. Develop comprehensive metabolomic database.
6. Expand metabolomics applications to many species.
7. "Grand Unification" of Genomic/Proteomic and Metabolomics technologies.

Advances in plant metabolomics in recent times has allowed the precise selection of desirable traits along with offering opportunities to undertake metabolically engineered plants. In the last decade, the implementation of metabolomics in conjunction with other omics technologies has not only uncovered a plethora of known as well as novel metabolites, but also allowed to determine their specific contribution towards- improving key plant attributes such as quality, yield, shelf life, etc. It is also very helpful for evaluation of genetically modified crops.

We anticipate that the integration of metabolomics and the other omics tools greatly improves the ability of a plant breeder in order to design and develop agronomically superior plants, thus enabling rapid development of high-performing crop genotypes that adequately meet the challenges of 21st century agriculture.

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Time Temperature Indicators (TTIs)

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Shashi Bala Ahirwar[1], Dr. Devendra Kumar Verma[2]
[1]Ph.D. Scholar, [2]Assistant professor
[1,2]Department of Post Harvest Process and Food Engineering, College of Agricultural Engineering, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh 482004, India.

The latest growth in intelligent packaging includes time temperature indicators for tracking the shelf life of packaged perishable products have garnered a lot of attention. A device or smart label known as a time temperature indicator" (TTI) displays the product's cumulative time temperature history. On food, pharmaceutical, and medical products, time temperature indicators are frequently used to indicate exposure to high temperatures. The shelf life of a food product is significantly influenced by temperature. Variations in the temperature profile can cause germs to thrive or survive, which ultimately leads to product deterioration. Moreover, improper freezing can cause the proteins in meat or other items to become denatured. Time temperature indicators can be used to determine whether the cold chain or a necessary temperature is correctly maintained along the food supply chain. (Fang Z., et. al. 2017).

Figure 1. Intelligent – packaging

Time temperature indicators or integrators are often small, low-cost accessories affixed to the product. The need to offer assurances of integrity, quality, and authenticity to food makers, merchants, and consumers alike has increased interest in intelligent packaging, which includes time-temperature indications. Temperature abuses, cold temperatures (go/no go basis), frozen temperatures (go/no go basis), partial history (response exceeding threshold), and full history are among the things that TTIs indicators must be capable of monitoring (continuous response).

Principle

The detection of time- and temperature-dependent mechanical, chemical, electrochemical, enzymatic, or microbiological changes in a food product is the foundation of the functional principle of TTIs. For instance, acid-base reactions or polymerization in response to time and temperature provide the basis for chemical or physical reactions. Contrarily, biological reactions are based on alterations in living things like spores, enzymes, or microbes in relation to temperature and time (Pavelková A. 2013). The measured data are frequently expressed as a visible response, like colour changes or mechanical deformations. Because of their straightforward functionality, TTIs are regarded as being user-friendly and accessible technology.

The Fresh-Check from Lifeline Technologies is a TTI indicator. It works by changing colour in the indicated range as a result of a polymerization reaction. A new TTI has a clear centre. The product needs to be consumed right away if the active center's colour matches that of the outside ring. Products with TTIs that aren't fresh have a dark centre. (Endoza T.F.M. et. al. 2004).

Classification of Time/Temperature Indicator's

Critical temperature indicators (CTI): show exposure at or above (or below) a target temperature. They only point out that the product was exposed to an unfavorable temperature for long enough to result in a change that was crucial to the product's quality or safety. Some significant situations where a CTI might be helpful include the growth of a pathogenic microbe or the denaturation of an essential protein above the critical temperature. They include a time component but are not intended to show a history of exposure above the critical temperature.

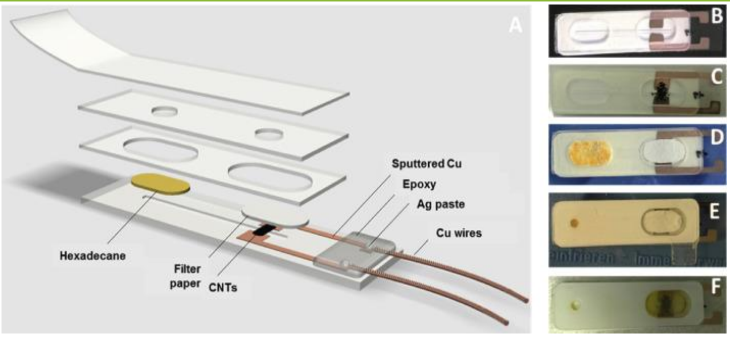

Figure 2. Critical temperature indicator

Critical temperature/time integrators (CTTI): It shows a response that reflects the cumulative time-temperature revelation above a reference critical temperature. One can convert their response into an identical amount of exposure time at the crucial temperature. It is helpful in identifying distribution chain breakdowns and for items where reactions that are crucial to quality or safety have initiated or are proceeding at measurable rates above a critical temperature. Microbial growth and enzyme activity that is suppressed below the critical temperature are two examples of these processes.

Time temperature integrators or indicators (TTI): It provides a consistent, temperature-dependent response across the course of the product's life, which is useful in combining initial to final time-temperature during distribution into a single measurement and correlating it to the identified quality loss reaction in food.

Current TTI systems: There are a large number of different time temperature indicators available in the market, based on different technologies.

Diffusion-based TTIs: The indicators can be used either as CTTI with the critical temperature equal to the melting temperature of the ester or as TTI if the melting temperature is lower than the range of temperature the food is stored.

Figure 3. diffusion based 3M Monitor Mark R time temperature indicator

Enzymatic TTIs: The temperature indictor is an enzymatic indicator. A color change caused by a pH decrease which is the result of a controlled enzymatic hydrolysis of a lipid substrate by an indicator. The indicator consists of two separate compartments, in the form of plastic mini-pouches before activation. Enzyme and substrate are mixed by mechanically breaking the barrier that separates the two compartments at activation. Hydrolysis of the substrate causes acid release the pH drop is translated in a colour change of the pH indicator from deep green to bright yellow.

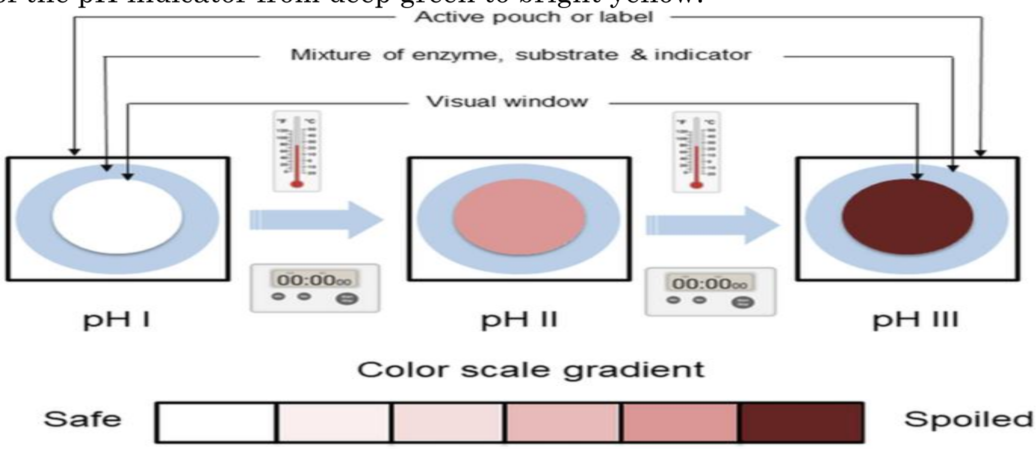

Figure 4. Enzymatic time temperature indicator

Polymer-based TTIs: It consists which includes a strip with a thin coat of the colorless diacetylenic monomer and two barcodes, one about the product and the other identifying the model of the indicator and in front it consists of an orthogonal piece of laminated paper. The change is perceived as a change from transparent to black as red and yellow colour.

Benefits of TTIs: accurate time-temperature data logger at a reasonable price. Easy to set up, small credit card-sized label. Wireless data transfer and configurable logging via mobile apps. increased sustainability and fewer shrinkages. gives information to help with inventory management, logistics, and shipping quality. TTIs are anticipated to decrease food waste and the incidence of food-borne illnesses because they assist in maintaining the cool chain of food goods.

Applications of TTIs: Food and beverages, Pharmaceutical and medical industries, Chemicals and polymers, other temperature-sensitive goods.

Conclusion

Systems for measuring temperature in real time deliver consistent results that meet client requirements. Time-temperature indicators display a visual summary of product temperatures over time, capturing the impacts of both time and temperature. During the entire life cycle of a food product, important factors like temperature should be tracked, recorded, and controlled as part of a modern quality and safety assurance system to prevent contamination. It continues from the moment of post processing till the consumer uses it. As a result, it's crucial to keep track of the temperature during distribution and storage.

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Future Era of Secondary Metabolites in Plant Disease Management

Article ID: 40755

Gaurav Rakhonde[1], Karibasappa CS[2], Debjeet Sharma[3], Aravind. T[4], Shivani[5]

[1]Ph.D Scholar, Department of Plant Pathology, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka, India-560065.

[2]Assistant Professor, Department of Plant Pathology, Palar Agricultural College, Kothamarikuppam, Tamil Nadu, India-635805.

[3]Ph.D Scholar, Department of Agriculture, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Himachal Pradesh, India-173230.

[4]Assistant Professor, Department of Plant Pathology, M. S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Odisha, India -761211.

[5]Ph.D Scholar, Department of Plant Pathology, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India- 263145.

Introduction

Crop protection has become an essential component of the production system, although at a high cost. The overuse of chemical pesticides obscured the impact of natural controlling agents such as microbial diseases. On account of the relevance and safety associated with effective suppression alternatives, secondary metabolites (SMs) have recently been emerged as an alternative.

SMs are chemicals that organisms make during stationary phase of cell development but are indispensable for growth. They are produced in response to environmental signals and aid in nutrition intake, defence mechanisms, communication between symbiotic and mutual hosts, and the capacity to withstand harmful substances. SMs are also biopesticides. Organic and synthetic chemistry advances accompanied the commercial aspects of these SMs. The primary contributing aspects to their performance as possible agrochemical solutions include target specificity, structural uniqueness, innovative modes of action, and environmental safety. (Maharana et al., 2022).

The use and application of these microbes in disease management has been familiar since time immemorial. In reality, due to their sluggish action in compared to chemical fungicides, adoption of these disease management methods by farming community is minimal. Interfering with fungicide maximum residue limits (MRLs) is becoming increasingly relevant for food and trade policy in the early twenty-first century. Residue levels differing across nations have the potential to dramatically impede commerce. (Arthurs and Dara, 2019).

Microbial pesticides are anticipated to be worth $4.5 billion by 2023. The fastest increasing category is microbial-based metabolites. *Bacillus thuringiensis* products have long dominated the microbial biopesticide industry, followed by entomopathogenic fungi and, more recently, antagonistic fungi such as *Trichoderma*. The discovery of bioactive chemicals in the bulk of these biopesticides and other dangerous bacteria has been assisted by advances in molecular methods. (Olson, 2015; Maharana et al., 2022).

Primary vs Secondary Metabolites

Primary metabolites are created by microorganisms during active cell development, often known as the logarithmic phase. SMs are formed towards the beginning of stationary phase. Primary metabolites are normally essential for the physiological development of an organism. These are generated in large quantities, whereas SMs, are produced in less quantities, appear to have no function in the physiological development of microorganisms. On account of chemical response to environmental stress and produced from primary metabolites. SMs are not involved in cell metabolism or microbial development. These are manufactured in non-growing or slow-growing cultures. The lengthening of the stationary growth phase is desirable for the development of SMs, formed when a nutrient is depleted and balanced growth becomes impossible. Antibiotics, growth boosters, and medicinal medicines are a few examples. (Donadio and Monciardini, 2002).

Classes of SMs

The four kinds of SMs are phenolic chemicals, terpenes, nitrogen-containing compounds, and sulphur-containing compounds. Polyphenols are extensively distributed SMs synthesized by shikimate-phenylpropanoids-flavonoids pathway. They work as antifungals, antimicrobials, and antipredators. Terpenes are lipid-soluble produced via mevalonate and deoxy-D-xylulose pathways and categorized according to quantity of isoprene units they contain. Many terpenes have distinct colors, flavors, and fragrances having insecticidal properties.

Terpenes in *Chrysanthemum* spp. of the *Meliaceae* family. have insecticidal action. Alkaloids are a diverse collection of nitrogen-containing SMs synthesized from amino acids or purine/pyrimidines. Nicotine, a well-known alkaloid with insecticidal and anti-herbivore action. Furthermore, an alkaloidal extract of *Peganum harmala* L. inhibited *Ralstonia solanacearum* Phylotype II, causing potato brown rot. Sulfur-containing chemicals are uncommon, although they play crucial part in plant defences.

The roles of sulphur-containing chemicals, glucosinolates and alliins, in plant defence mechanisms are being researched extensively. Many glucosinolate hydrolysis products are very toxic to birds, insects, nematodes, bacteria, and fungus, acting as poisons, growth inhibitors, or feeding deterrents. (Choudhary et al., 2021).

Biosynthetic Pathway of SMs

The precursors of metabolites are essentially produced in the krebs cycle and shikimate pathway. The phenolic compounds are synthesized in the shikimate pathway, terpenes synthesized in the mevalonic pathway, and nitrogen-containing compounds synthesized in tricarboxylic acid cycle pathway (Thirumurugan *et al.,*2018).

Application

Lucensomycin, a polyene macrolide isolated from *Streptomyces plumbeus* strain CA5, significantly decreased disease incidence of grey mould on grapes. Lucensomycin prevented *B. cinerea* spore germination at concentrations as low as 1 mg L^{-1} and fully stopped grey mould formation on grapes at 100 mg L^{-1} (Do Kim *et al.,* 2020). In the fungus confrontation zone engaged in the interaction between *Penicillium digitatum* and *Penicillium citrinum*, two tetrapeptides, deoxycitrinadin A, citrinadin A, chrysogenamide A, and tryptoquialanines are formed, and antifungal activity is validated by antimicrobial testing. *P. citrinum* sporulation was hindered by tryptoquialanines (Costa *et al.,*2019).

Merits of SMs

1. SMs approach is Eco-friendly.
2. It is target specific.
3. SMs will avoid the issues of residue, resurgence and slow down the resistance.
4. It is the good combination in IPM.
5. SMs will prevent or delays resistance or cross resistance development.
6. SMs application is safer for application.
7. SMs is a good alternative to chemical approach.

Challenges of Secondary Metabolites

1. SMs is slow to kill the pathogen.
2. SMs production has difficulty.
3. SMs shelf-life maintenance.
4. SMs consistency in its performance.
5. Cost issues.
6. Availability of products of SMs.
7. Selection of secondary metabolites as per pathogen.
8. Purity and viability of SMs.
9. SMs dose of application.
10. Regulation bodies to regulate.
11. Lack of Research in SMs era.

Conclusion

SMs have a bright future in crop protection. SMs will be a useful alternative in agriculture. It will increase PGPR activity and promote defensive mechanisms rather than only crop protection. SMs will be exploited as biopesticides and have significant agrochemical potential. Resistance development will be hindered and emergence of new pathogen races slow down. Thus, it will usher in a new era of crop protection. More research is required to make it useful in field. Research is required in the creation of formulations, storage, dosages, control, and other effects on agricultural plants along with in post-harvest applications.

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Association Mapping in Crop Improvement

Article ID: 40756

Padmashree R[1], Honappa M[2], Umesh Babu B. S[3]
[1]Junior research fellow ICAR-Indian institute of Rice research Hyderabad-500030.
[2]Assistant Professor (GPB)Agricultural Horticultural Research Station (AHRS) Ponnampet, Kodagu, Karntaka-571216.
[3]Ph.D. Research Scholar, Department of Genetics & Plant Breeding, Raichur, Karnataka-584104.

Agriculturally important variations such as productivity and quality, tolerance to environmental stresses and disease resistance are controlled by polygene (minor genes)- referred as quantitative trait loci (QTLs). Genetic dissection of complex traits is important for crop improvement; however, it is challenging to identify QTLs based on only traditional phenotypic evaluation. DNA markers can be used as proxies to track key QTLs controlling economically important traits through gene mapping. Genetic mapping can be done in two ways, i) using family based bi-parental mapping populations having few meiotic recombinants (referred as QTL-mapping) and ii) using diverse lines with historical meiotic recombinants from the natural populations or germplasm collections (referred as Association Mapping) (Gupta*et al*., 2005).

The terms Linkage Disequilibrium (LD) and Association Mapping (AM) have often been used interchangeably in the literature. AM refers to the significant association of a marker locus with a phenotype trait while, LD refers to the non-random association between two markers or two genes/QTLs. Thus, AM is an application of LD and AM approaches are therefore based on LD between markers and trait controlling loci. Several statistics such as D, D′, r^2 *etc*., have been proposed for quantifying LD. There are so many factors whichplay vital role in the shaping LD blocks in crop genomes, include small population size, new mutations, low recombination rate, gene flow, kinship, genetic drift, natural and artificial selection*etc*., and the extent of LD - dictate the number of markers to be used in the association mapping (Garcia *et al*., 2003).

There are two main approaches for AM *viz*., candidate gene-based association mapping and genome-wide association mapping (GWAS). A number of software packages are available for AM and ‘TASSEL’ is most commonly used software for LD mapping in plants.AM offers three main advantages over QTL mapping: mapping resolution, it could identify causal polymorphism within a gene responsible for phenotypic variation, high allele number and time saving in establishing a marker-trait association. (Kumar *et al*., 2017).

Swamy *et al*. (2017) reported association mapping for yield and yield related traits under reproductive stage drought stress in rice. Malaysian rice germplasm was used to characterize and to identify significant marker trait associations for yield and yield related traits. The drought screening was successful in screening germplasm with a yield reduction of upto 60 per cent and heritability for grain yield under drought was up to 78per cent. Structure analyses clearly grouped the accessions into 3 subgroups with admixtures. The mixed linear model-based (MLM) structured association mapping identified 80 marker trait associations (MTA) for grain yield (GY), plant height (PH) and days to flowering (DTF). Seven MTA were identified for GY under drought stress, four of these MTA were consistently identified in at least two of the three analyses. Most of these MTA identified were on chromosomes 2, 5, 10, 11 and 12, and their phenotypic variance (PV) varied from 5 *per cent* to 19 *per cent* The *in-silico* analysis of drought QTL regions revealed the association of several drought-responsive genes and finally study concluded that structured association mapping is one of the feasible options to identify major-effect QTLs for drought tolerance-related traits in rice.

Zhao *et al*. (2018) inferred significant differences in root thickness (RT), root weight (RW) and shoot weight (SW) by association mapping. However maximum correlation was observed between RW and SW. 17 and 10 QTLs were identified for root and shoot traits respectively. More common QTLs with high phenotypic variation effects (PVEs) between root and shoot traits suggested that longitudinal growth that is root and shoot length played an important role in accumulation of biomass that is RW and SW.

Major agriculturally economic traits are of complex nature these can be dissected by advanced genomic tools like association mapping. Linkage Disequilibrium or association mapping is a novel approach in plants, presenting opportunities to exploit the genetic variation in natural populations for high-resolution mapping of simple and complex traits, and is a one of the valuable options for effective and efficient utilization to accelerate crop improvement.

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The Real Status of Transgenic Crops around the Globe

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Bhamare D. P[1]., Arora A. A.[2]
[1]Ph.D. Scholar, School of Agricultural Biotechnology, PAU, Ludhiana-140104.
[2]Ph.D. Scholar, Dept. of Plant Breeding and Genetics, PAU, Ludhiana-140104.

Transgenic Plants

Plants that have introduced/ stably integrated and expressed foreign genes or genes are called transgenic plants. It is basically a combination of three main stream i.e. a. Recombinant DNA technology b. Gene introduction methods and C. Plant tissue culture. The host genotype does not require backcrossing to have a plant genotype equivalent to an agronomically superior variety, which avoids the problem of transferring undesirable genes along with the target. Thus, through transgenesis, the host genotype is least disturbed.

Why do we Need Transgenic Plants?

1. To meet the demand of changing climate conditions: Global climatic conditions have been changing significantly over the last few decades. Increasing temperatures, extreme droughts, and sudden rainfalls have put major stress on crop production. The development of sustainable agriculture through classic agronomic and breeding strategies are not sufficient to tackle the problem of changing climate conditions.

2. A solution in problems like major genetic bottleneck due to rapid domestication: Rapid domestication has revolutionized farming but due to the selection of favorable traits, other traits get eliminated ultimately reducing genetic variability. So, natural sources of resistance against biotic and abiotic stress are limited.

3. Cut down time to find a solution for problems: The development of climate-resilient varieties of different crops takes significant time while transgenic crop gets developed in lesser time compared to conventional breeding.

4. To control damage caused to the environment and ecology due to excessive use of chemicals: Agrochemicals plays a prime role in controlling pest and disease as well as controlling weeds. This extensive use of agrochemicals is damaging to the environment as well as killing non-target insects harming the balance of ecology. The use of chemical pesticides alone in India for year 2021-2022 was 58720 Metric Tons. The development of disease and insect-resistant transgenic plants can reduce the use of agrochemicals as well as the protection of non-target species.

Why Transgenic Plants are Strictly Regulated?

1. Environmental Risk: The use of transgenic plants may lead to the creation of superbugs or superweeds due to resistance or transgene escape. It is a long-term speculation amongst the scientific community regarding transgene escape but no validated reports are available for this claim.

2. Food safety: Transgenic plants contain antibiotic resistance markers to facilitate the selection procedure giving rise to the question about the safety of food.

3. Ethics: The source of genes used in transgenic plants are diverse i.e. plants, bacteria, animals, etc. which gives rise to ethical issues regarding the consumption of such food.

Regulation of Transgenic plants in India

India is under signee of Cartagena protocol for biosafety having Ministry of Environment, Forest and Climate Change (MOEF&CC), Government of India as nodal agency Department of biotechnology (DBT) is involved with monitoring of GMO production with help of various committees like IBSC (Institutional Biosafety committee), RCGM (Review Committee on Genetic Manipulation), DLC (District Level Committee), RDAC (Recombinant DNA Advisory commitee). GEAC (Genetic Engineering Approval Committee) is nodal agency of MOEF&CC.

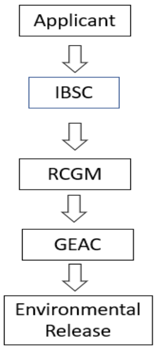

Fig.1: Schematic representation of application for regulation

Biotech Crops in India

Cotton: It is the only approved crop for commercial production in India. It was introduced in 2002 and reintroduced in 2006 after certain modifications. Bt cotton has grown exponentially since 2002 and resulted in reduced yield loss occurred due to insect attacks by 60%. Currently, India ranks 2nd in the world after China in.

Global Status of GM Crop

Timeline:

1980- US supreme court allowed patenting of GE organism
1992- FlavrSavr tomato approved for commercial cultivation by USDA
1995- USDA approved insecticide-producing plant
1996- Herbicide tolerance maize was introduced for cultivation
2002- Bt Cotton was introduced into India
2013- Bt Brinjal cultivations allowed in Bangladesh
2021- Bt Brinjal cultivation approved in Philippines
2021- Golden rice was accepted for cultivation in Philippines.

Transgenic Crops Under Trail: Worldwide

Sr. No.	Plant	No of Events	Trait
1.	Alfalfa	5	Herbicide tolerance
2.	Apple	3	Disease resistance, Non Browning
3.	Argentina canola	41	Herbicide tolerance, Phytase reduction, Pollination control system
4.	Bean	1	Viral disease resistance
5.	Carnation	19	Herbicide tolerance, Modified flower color
6.	Chicory	3	Herbicide tolerance, Pollination control system
7.	Cotton	66	Herbicide tolerance, Insect resistance, low gossypol
8.	Cowpea	1	Insect resistance
9.	Creeping bent grass	1	Herbicide tolerance
10.	Eggplant	6	Herbicide tolerance
11.	Eucalyptus	1	Volumetric wood increase, insect resistance
12.	Flax	1	Herbicide tolerance
13.	Maize	152	Herbicide tolerance, Insect resistance, Modified quality
14.	Melon	2	Delayed ripening
15.	Papaya	4	Viral disease resistance
16.	Petunia	2	Modified color
17.	Pineapple	1	Delayed ripening, modified fruit color
18.	Plum	1	Disease resistance
19.	Polish Canola	4	Herbicide tolerance

20.	Poplar	2	Insect resistance
21.	Potato	50	Insect resistance, Modified starch quality, Reduce black spot, Lower reducing sugar, Asparagine free
22.	Rice	15	Nutritional enhancement, Salt tolerance, Water use efficiency, Drought tolerance
23.	Rose	2	Modified flower color
24.	Safflower	2	Modified fatty acid
25.	Soybean	40	Herbicide tolerance, modified fatty acid
26.	Squash	2	Viral disease resistance
27.	Sugarbeet	3	Herbicide tolerance
28.	Sugarcane	6	Insect resistance, Drought tolerance
29.	Sweet Paper	1	Viral disease resistance
30.	Tobacco	2	Herbicide tolerance, Lowered Nicotine level
31.	Tomato	10	Viral disease resistance, Delayed ripening
32.	Wheat	2	Drought tolerance, Herbicide resistance

**Highlighted text represents commercially released GM crops.

The Economic Impact of Transgenic Crops on Farmers

Transgenic farming has uplifted the economic status of farmers across the globe. GM herbicide tolerance technology in soybeans has boosted farm incomes by $4.8 billion, and since 1996 has delivered $37 billion of extra farm income. Of the total cumulative farm income gains from using GM HT soybeans, $13.9 billion (38%) has been due to yield gains and/or second crop benefits, and the balance, 62%, has been due to cost savings. In 2012, the total global farm income gain in maize using this technology was $1.2 billion with the cumulative gain over the period 1996–2012 being $5.4 billion. Within this, $1.4 billion (26%) was due to yield gains, and the rest derived from lower costs of production. The use of GM HT cotton delivered a net farm income gain of about $147 million in 2012. In the 1996–12 period, the total farm income benefit was $1.37 billion. Similarly, the GM insecticide resistance traits, used in maize and cotton, have accounted for 96.1% of the additional maize production and 99.3% of the additional cotton production and the average yield impact across the total area planted to these traits over the 17 years since 1996 has been +10.4% for maize and +16.1% for cotton. Overall GM technology has regulated the economy of farming positively by majorly by reducing the cost of production and yield gains.

Conclusion

Transgenic crops are strictly regulated prior to their introduction into the market for consumption and are safe to use. The labeling of food products as GM helps the consumer to make their choices for the consumption of GM food. Owing to the current scenario of climate change, food requirements and depleting natural sources of variation for different traits, transgenic crops are going to be an efficient solution for tackling these problems.

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Transcriptome Analysis in Crop Improvement

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Padmashree R[1], Honnappa M[1], Umesh Babu B. S[1]
[1]University of agricultural sciences, Raichur-584101.

Transcriptome is the complete set of messenger RNA (mRNA) and non-coding RNA (ncRNA) transcripts produced by a particular cell, cell type, or organism. Transcriptome analysis has been a key area of biological inquiry for decades. Over the years, research in the field has progressed from candidate gene-based detection of RNAs using Northern blotting to high throughput expression profiling driven by the advent of microarrays. Next-generation sequencing technologies have revolutionized transcriptomics by providing opportunities for multi-dimensional examinations of cellular transcriptomes in which high-throughput expression data are obtained at a single-base resolution (Ozsolak*et al*., 2011).

The technology is not only a powerful tool for discovering the full length of 5′ and 3′ untranslated regions, novel splice junctions, novel transcripts, alternative transcription start sites and rare transcripts, but can also detect and quantify gene expression using digital measurements and is especially sensitive for low-expressed genes. In addition, RNA-seq data show a high level of reproducibility in both technical and biological replicates.

The differences in pigmentation between brown, green and white cotton fiber was mined by the molecular study of structural genes of flavonoid biosynthesis pathway. The transcriptome analysis of five flavonoid biosynthesis related structural genes, encoding chalcone isomerise, flavanone 3-hydroxylase, dihydroflavonol 4-reductase, anthocyanidin synthase (GhANS) and anthocyanidinreductase (GhANR) was performed at two fiber developmental stages i.e. 10 DPA and 20 DPA. The transcript level of all structural genes was higher in brown cotton fiber as compared to green and white at both 10 DPA and 20 DPA. The decline in the transcript level of all structural genes except *GhANS*was observed at 20 DPA as compared to 10 DPA. Correlating these findings with the flavonoid biosynthetic pathway revealed that *GhANR*and its substrate *GhANS*are crucial for the synthesis of proanthocyanadines, which is a brown pigment and transcripts of structural genes are directly proportional to the brown pigment (Malik *et al*., 2015).

The differences between the transcriptomes of heat-tolerant and -sensitive rice lines in response to high night temperature stress at the early milky stage was described for the first time using illumina sequencing technology. The transcriptomic analysis revealed that the candidate transcripts may provide genetic resources that may be useful in the improvement of heat-tolerant characters of rice (Liao *et al*., 2015).

Transcriptome sequencing by next-generation technologies provide resources for gene expression profiling studies as well as simultaneous identification of mutations, sequence aberrations, alternative splice variants, gene markers and RNA editing events. However, the new technologies have profound opportunities in other areas of genomics, such as genome sequencing and epigenome analysis.Despite the many attractive prospects offered by transcriptome sequencing on next generation platforms, still needed are advances in sequencing data analysis and the development of suitable computational tools that can be used to effectively process massive amounts of sequence data.

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Dragon Fruit: Wonder Fruit of the 21st Century

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Tanmoy Mondal[1], Mahabub Alam[1]
[1]Research Scholar, Department of Fruit Science, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India.

Introduction

Dragon fruit, also known as pitaya or pitahaya, is a tropical fruit originated from South America and it belongs to the Cactaceae family. It is prevalent in two separate genera namely, '*Hylocereus*' and '*Selenicereus*'. The *Hylocereus* genus, which includes around 16 different species, has the most commercially cultivated varieties (Bellec *et al.*, 2006). It is also known as strawberry pear, Night blooming Cereus, Belle of the night, Conderella plant pitayaroja (Spanish), thangloy (Vietnamese), and la pitahaya rouge (French) (Jalgaonkar *et al.,* 2020; Perween *et al.,* 2018). In India, mainly two varieties are grown: a red skinned fruit with deep red flesh (*Hylocereus polyrhizus*; RF) and a pink-skinned fruit with white flesh (*Hylocereus undatus;* WF).

It is gaining tremendous popularity among growers due to its appealing fruit colour and mellow mouth melting pulp with edible black seed imbedded inside the pulp, nutraceutical value, excellent export potential, and highly remunerative in nature as it produces yield from 14- 16 months after planting and yield up to 25-30 years with a long crop cycle from May to November with six to seven flushes each year. It is a long-day plant with a magnificent night-blooming flower which has given it the nickname "Noble Woman" or "Queen of the Night". It has ornamental significance because of the massive (25 cm) flowers that bloom at night and are creamy white in colour. Because of the bracts or scales on the fruit's skin, the fruit is called pitaya, which means "the scaly fruit" (Perween *et al.,* 2018).

Origin and Distribution

The majority of *Hylocereus* species are native to Mexico, Central America, and South America (Mizrahi *et al*., 1997 and Daubresse Balayer, 1999). *Hylocereus sp*. are now found all over the world (in tropical and subtropical areas), however in India, *H. undatus* is the most widely distributed species, followed by *H. costaricensis*. Because of its hardiness, this fruit crop can withstand the extreme weather conditions of India's arid and semi-arid regions. *Hylocereus* species are semi-epiphytes, meaning they prefer to grow in half-shade (as provided by trees in nature), but certain species, such as *H. undatus, H. costaricensis,* and *H. purpusii*, may be cultivated in full sun. However, excessive heat and a lack of water can cause stem burning and flower bud drop. The most favourable circumstances for *H. polyrhizus* growth and fruit production in Israel's Neveg Desert were determined to be 30 percent shade (Raveh *et al*., 1998). Now it is commercially grown in Israel, Vietnam, Taiwan, Nicaragua, Australia and the United States (Merten, 2003).

Composition and Uses

The fruit is consumed by eaten fresh and made into several processed products. Pitaya has been utilised in Mexico as a meal and for its medicinal benefits since prehispanic times (Clerck and Negreros-Castillos, 2000). The fruit is consumed fresh or used to make wine, juice, jelly, yoghurt, jam, preserves, and other delicacies (Herbach *et al*., 2006; Shetty *et al.,* 2012). Fermentation rates, lactic acid content, syneresis percentage, antioxidant activity, and yoghurt total phenolic content all improve when *H. monacanthus* or *H. undatus* pulp is added (Zainoldin and Baba, 2012). The fruit pulp of *H. monacanthus* is high in fibre, vitamin C, minerals, and phytoalbumin, all of which confer significant antioxidant qualities (Jafaar *et al*., 2009). Protein, fat, fibre, ash, and antioxidants are all abundant in dried juice. (Rebecca *et al*., 2010). Pitaya peels are high in naturally occurring phenols and flavonoids. (Hua *et al.,* 2018). Because of the free radical scavenging activity of the phenol moiety, phenols act as antioxidants (hydroxyl substituent on the aromatic ring). Caffeic acid is known to selectively block the biosynthesis of p components involved in immune regulation disorders, asthma, and allergic reactions, in addition to its p behaviour (Yasuko *et al*., 1984). Pitaya seed oil contains a powerful natural antioxidant source that contains phenolics, tocopherols, and sterols. Seeds have a higher concentration of linoleic acid than flax seed, canola seed, sesame seed, or grapevine seed. Betainic phenolic compounds contribute the most to the antioxidant capacity of purple-red pitaya, while non-betalainic phenolic compounds contribute the least (Esquivel *et al.,* 2007). The skin and flesh of dragon fruits contain a rare organic compound called citramalic acid, which can help people reduce wrinkles on their faces and has potential use in medicine and cosmetics (Wu *et al*., 2020); Citramalic acid was found in only a few plants, and the levels were significantly lower than in dragon fruit. Young stems of *H. undatus* are reported having high nutritional composition and are eaten as vegetable (Juárez-Cruz *et al*., 2012). Fresh flower buds are consumed as vegetables, in China under the named "Bawanghua", while dried flower buds are used to make folk remedies (Perween *et al.,* 2018). Dry flowers are eaten as a vegetable in Taiwan (Mizrahi and Nerd, 1999). The biochemical attributes of pitaya vary depending on the stage of maturation and the environment in which the fruits grow.

Table 1: Proximate nutritional composition, minerals and vitamins content of red-flesh dragon fruit are as follows (Per 100 g edible portion):

Moisture	85.1-90.0 %	Vitamin C	25.0-30.2 µg
Protein	0.4-1.5 g	Vitamin A	85.2-891.0 µg
Fat	ND	Vitamin E	0.26mg
Total dietary Fiber	2.7g	B- carotene	1.4 ig
Energy	35.4-63.0 Kcal	Lycopene	3.4ig
Ash	0.5-1.2 g	Fe	0.03-0.3 mg
Carbohydrates	8.4-13.0 g	Mg	13.7-26.4 mg
TSS	8-12 °Brix	Ca	1.6-6.7 mg
pH	4.4	K	158.3-437.4 mg
Tithable acidity	0.20-0.30 mg	Na	14.3-35.6 mg
Pulp/peel ratio	1.3-1.7	Zn	0.1-0.4 mg

Source: *Bose et al*., 2021.

Table 2: Proximate nutritional composition, minerals and vitamins content of white-flesh dragon fruit are as follows (Per 100 g edible portion):

Moisture	85.3%	Vitamin C	3.0
Protein	1.1 g	Vitamin A	0.01
Fat	0.57	Niacin	2.8
Crude Fiber	1.34 g	Zn	0.35 mg
Energy	67.7 Kcal	Ca	10.2 mg
Ash	0.56 g	Fe	3.37 mg
Carbohydrates	11.2 g	Mg	38.9 mg
Glucose	5.7	P	27.75 mg
Fructose	3.2	K	272.0 mg
Sucrose	not detected	Na	8.9 mg

Sorbitol	0.33		

Source: Perween *et al*, 2018

Industrial Uses

Besides used as fresh table fruit, it is also taken in the form of juice, jam, or preserves according to the taste needed. Dragon fruits can be processed by freezing, concentration, dehydration, fermentation, thermal processing and chemical conservation. The most important fruit pigments in red dragon fruit are the betalains such as the betacyanins and betaxanthins. The production of natural colourant from red or purple pitahaya (*H. monacanthus* and *H. costaricencis*) pigments are potential colourant sources for the food industry. The mucilage extracted from fruit peel has rheological qualities, which is use as an encapsulating agent for active principles under optimized spray drying could be possible. For processing and storage, these Betacyanins are extremely stable. The betalins from the peel were found to be stable over a pH range of 3.2 to 7.0 and were resistant to heating (100°C) for up to 10 minutes at pH ranges of 3.7 to 5.5 (citation,0000 if available). This property helps pitaya peel to be used in low acidity foods with mild heat treatment, or to be added to food after it is heated. Betanin, isobetanin, phyllocactin, isophyllocactin, betanidin, isobetanidin, bougainvillein-R-1, hylocerenin, and isohylocerenine have all been isolated from *H. monacanthus*. Some *H. costaricensis* clones contain more betanin and isobetanin, whereas others contain more phyllocactin and hylocerenin (Bose *et al*., 2021).

Health Benefit

It has several health purposes and has been commercialized as a healthy beverage in China. The fruit has medical properties, including the ability to prevent colon cancer and diabetes, as well as neutralise hazardous chemicals like heavy metals and reduce cholesterol and blood pressure. It can prevent cancer and bleeding, as well as reduce high blood sugar levels and boost dental health. The dragon fruit helps digestion and reduce fat. Because it contains a high level of vitamin C, regular consumption of Dragon fruit aids in the treatment of coughs and asthma; it also aids in the rapid healing of wounds and injuries. The high content of vitamin C in Dragon fruit, on the other hand, helps to boost the immune system and encourage the activity of other antioxidants in the body. It helps improves the eye sight. The fruits of *H. undatus* are used to treat heart illness, hypoglycaemia, wound disinfection, tumour dissolution with stem sap, and dysentery. The peel and pulp of *H. moncanthus* include phytochemically bioactive substances that are effective antioxidant and anti-proliferant nutraceuticals and this compound is enrich with polyphenols, and peel could inhibit cancer cell growth (melanoma B16F10 and other types). In terms of fertility, the fruit of *H. costaricensis* enhanced sperm count, viability, and rate of production.

Conclusion

Dragon fruits are attractive in shape and colour, and possess excellent nutraceutical properties which attract the consumers as well as the growers from all over the India. The red fleshed species, *H. costaricensis*, is also high in betalains, which caters to the growing demand for antioxidant rich products and natural food colourants. This fruit crop needs further researches in different aspects of production and value-added products.

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LAC Processing and its Role in Indian Economy

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Mangal Sukhi Meena[1], Hemant Swami[2], Neeraj Kumar Meena[3]
[1,2]Department of Entomology, Rajasthan College of Agriculture, MPUAT Udaipur (Raj.) India.
[3]Department of Plant Pathology, Rajasthan College of Agriculture, MPUAT Udaipur (Raj.) India.

Introduction

Its earliest reference is found in Atherva Veda. Therefore, the insect is termed as 'Laksha', and its habit and behaviour are described. Since ancient times, Greeks and Romans were familiar with the use of lac. There are some findings that lac production and trade in China is almost 4000 years and developed along with silk. The English word lac synonyms Lakh in Hindi which itself is derivative of Sanskrit word Laksh meaning a lakh or hundred thousand. It is also worth to mention that a laksh griha would need a lot of lac, which could only come from a flourishing lac industry in that period. Lac is the only known commercial resin of animal origin. To produce 1 kg of lac resin, around 300,000 insects lose their life. The lac insects yields resin, lac dye and lac wax. Application of these products has been changing with time.

LAC Insect Taxonomy

The first scientific account of the lac insect was given by J. Kerr in 1782 which was published in Philosophical Transaction of Royal Society of London. The first scientific name given to it was Tachardia lacca following the name of French Missionary Father 'Tachardia'. It was later changed to Laccifera lacca Kerr.

Phylum – Arthropoda, Class - Insecta
Order – Hemiptera, Suborder - Homoptera
Super family – Coccoidea, Family - Lacciferidae
Genus – Laccifera/ Kerria, Species – lacca
Lac insect of South East Asia is referred to as Kerria chinensis. Lac insect belongs to super family Coccoidea which includes all scale insects.

Distribution

India and Thailand are main areas in the world, while India has leading position in relation to lac production. Lac cultivation is introduced into Thailand from India. Over 90% of Indian lac produced comes from the states of Bihar, Jharkhand, West Bengal, Madhya Pradesh, Chhattisgarh, Eastern Maharashtra and northern Orissa. Some pockets of lac cultivation also exist in Andhra Pradesh, Mysore, Gujarat and Mirzapur and Sonebhdra districts of Uttar Pradesh. In India, lac is cultivated in 50 districts spread over 12 states. A total of 16978 tons of raw lac was produced in 2017. In Jharkhand, lac cultivation constitutes the second most important source of rural family income. Due to its diversified uses, demand of lac is increasing globally and price of the commodity is also in its increasing trend.

LAC Processing

Stick lac: Following harvest, lac encrustations are removed from the twigs of host plant by scraping. The raw lac thus obtained is known as raw or crude lac or scraped lac or stick lac. This crude lack consists of resin, encrusted insect body, lac dye, sand and twig debris. The freshly scraped lac contains a lot of moisture and usually left to dry. The quality and value of stick lac depend very much upon variety of factors, viz. host tree, climate, whether the crop is harvested before or after emergence of larvae, and the method of drying and storage. The stick lac cannot be stored for longer duration, as the lac has tendency to form lump, and there is loss in quality of lac. High moisture content is responsible for lump formation. The optimum moisture content has been identified to be 4% for storage of stick lac to avoid lump formation.

Seed lac: The primary processing to seed lac soon after harvesting is necessary, because the storage of stick lac is more congenial for lump formation and breeding of storage pests, and thereby causing substantial loses and deterioration in quality of desired industrial parameters. The stick lac is crushed and sieved to remove sand and dust. It is then washed in large vats again and again to break open the encrusted insect bodies, to wash out the lac dye and twig debris. Decaying bug bodies turn the water a deep red that is processed further to get the byproduct lac dye.

Shellac: The shellac is the name of finished product and is commonly used across the world. Seed lac is processed into shellac by any of the three methods: hand made country Process or heat process or solvent process.

Hand made Process: Traditionally seed lac is processed by hand. The seed lac is filled into long sausage shaped cloth bag of about 2 inch diameter and 30 feet long. The long bag is passed gradually in front of a charcoal-fired hearth hot enough to melt the lac. By twisting the bag, molten lac is squeezed out through cloth. The residue left inside cloth bag is another variety of refuse lac known as kirilac. The molten filtered mass is stretched into sheets approximately 0.5 cm thick and thinner by skilled work man with the help of glazed ceramic cylinder. Alternatively, the molten mass is allowed to solidify in form of discs, and then it is called as 'button lac'.

Heat Process: In this process of manufacturing of shellac, the seed lac is melted by steam heat. The molten soft lac is squeezed through filter by means of hydraulic pressure. The filtered molten lac is drawn into long and continuous sheets with help of roller. The sheet is then broken into pieces called flakes.

Solvent Processes: If the solvent process is used to purify the semi refined lac, dewaxed and decolorized shellac can be obtained as end product. The normally amber colour resin can also be bleached to get bleached shellac. Seed lac is dissolved in a refrigerated alcohol and filter through filter press to remove wax and impurities. The colour may be removed to any required standard by charging with the activated carbon and then alcohol is recovered. The molten shellac is stretched with a roller.

Role in Indian Economy

Bleached shellac is widely used in the following industry: Paints (primer for plastic parts and plastic film), Aluminium industry (primer for Aluminium and Aluminium foils), Flexographic printing inks, Pharmaceuticals (for coating of pills, tables and gel capsules), Confectionery (in coating of confections, chewing gums, marzipan chocolates, nutties, jelly- and coffee-beans etc), Binder for food marking and stamping inks and Binder for egg coating, Barrier coating for processed food, vegetables, fruits and dry flowers, Textiles (used as textile auxiliaries and felt hat-stiffening agents), Cosmetics (used in hair spray, hair and lacquers, hair shampoos, and binder for mascara).

Conclusions

Lac insects are exploited for their products of commerce, i.e., resin, dye and wax. Cultivation of lac not only provides livelihood to millions of lac growers, but also helps in conserving vast stretches of forests and biodiversity associated with lac insect complex. Promoting and encouraging lac culture will not only check environmental degeneration but also conserve associated fauna and flora for posterity.

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Summer Management of Poultry

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Pallavi Dattatray Mali[1], Akshay Pramod Chawke[1], Abasaheb K. Parade[1]

[1]Ph.D. Research Scholar, Department of Animal Husbandry and Dairy Science, Mahatma Phule Krishi Vidyapeeth, Rahuri-413722 Dist. Ahmednagar, Maharashtra, India.

Introduction

Poultry is one of the important sectors of agriculture. Climate change and Seasonal variation adversely affects on growth and egg production of birds. The optimum temperature for performance of poultry is likely to be 18 to 24^{0}C. Usually from March to May, the temperature is higher (more than 30^{0}C), during that birds can experience heat stress. Due to high body temperature and absence of sweat glands poultry birds are more prone to heat stress. Heat stressed birds are unable to balance between body heat production and body heat loss. Moreover, declined immune system and reduced the meat quality and egg quality are observed. Eventually, severe heat stress will result in the death of birds. So, to get more profit poultry farmer should change management according to climate change.

Sign of Heat Stress in Poultry

1. Panting with open mouth
2. Spreading of wings to reduce insulation
3. Birds tries to move away from other birds
4. Crouch near wall or wet places
5. Rest to reduce heat generated by activity
6. Reduction of egg production
7. Production of small size egg and poor shell quality eggs
8. Less body weight gain in broilers
9. Reduce feed intake and feed efficiency
10. Increase water intake
11. Heat stress causes death of birds.

Management of Poultry in Summer

Housing Management:

a. Orientation of poultry shed should be East-West to prevent direct sunrays into shed.
b. Before onset of summer, the roofs should be cleaned and painted with white paint, lime.
c. Around poultry shade make tree plantation, they act as warm wind breaker.
d. Put grass or gunny bags over roof to reduce reflected radiation.
e. Put the gunny bags on sides of the house or on windows and frequently wet them during hot summer. Wind blowing over wet gunnies will cool the house.
f. In hot weather use of sprinkler and fogger with fan helps in reduce the temperature inside the poultry shed.

Water Management:

a. During hot weather water requirement of birds increases.
b. Birds provide plenty of fresh, clean and cool drinking water.

c. Normally, birds drink two-liter of water per kg of feed. Birds drink 4% more water for every one degree increase in temperature above 70^0 F.
d. Birds like to drink cool water during 45^0 F to 80^0 F. As same for day-old chicks provide cool water with electrolytes on their arrival to farm.
e. Increase number of waterers by 25% and increase frequency of watering.
f. Along clean water addition of 0.25% of salt to drinking water increases water consumption.

Feeding Management:

a. Adequate care should be taken in feeding management of chickens during summer. Feed intake is more during early in morning and in the evening time. Provide more feed during that time.
b. Increase number of feeders by 10%, which increases feed consumption.
c. Add 2-3 % oil or fat (linseed, vegetable oil, fish oil etc.) in ration of birds to reduce heat increment and relieve from heat stress.
d. Increase the calcium level from 3-3.5% in egg producing chickens.
e. Similarly, 20-30% extra vitamins and trace minerals should be added to feed.
f. Vitamin A-8000 IU and Vitamin E-250 mg/kg which helps in reducing heat stress in birds.

Other Management:

a. Litter should be at least 2 inch in depth. Wet litter 2-3 times during summer.
b. Avoid overcrowding by increasing floor space/bird.
c. Stocking density should be reduced by 10% in hot weather.
d. Cover water tanks with wet gunny bags to avoid direct exposure to sun.
e. Vaccination and changing the location of birds should be done at night.
f. After excessive heat stress on the birds, birds should be immersed in water for 2-3 minutes. The beak and eyes should be raised above the water level.
g. Beak trimming to prevent feather picking and cannibalism which is more in hot weather.
h. We can use some herbs to reduce stress caused by heat in birds. Amla, Tulasi, Shatavari, Ashwagandha etc. can be used in the diet of poultry.

This way by adopting proper feeding management, water management and housing management practices we can minimize heat stress and birds remains healthy and improve performance under high environmental temperature in summer.

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Rise of Red Gold 'Saffron' Cultivation in Darjeeling Hills of West Bengal

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Bikram Saha[1], Uriti Nitin Kalyan[1], Lakshmi M[1], Dr. Amit Kotiyal[2]
[1]B.Sc [Hons] Agriculture student, Lovely Professional University, Punjab.
[2]Assistant Professor, Department of Horticulture, Lovely Professional University, Punjab.

Introduction

The spice "saffron" is the most expensive in the world and is made from the Crocus sativus plant. "Red Gold" is a common nickname for saffron. Saffron can grow anywhere in the world, and cultivating it is very easy and open to everyone. Saffron is typically expensive because of the heavy labour required to harvest the crop, not because it is challenging to grow. The saffron plant is a perennial bulbous plant that grows 15 to 20 cm tall and has globular corms. This plant grows in Mediterranean nations like Spain, Austria, France, Greece, England, Iran, and Turkey and is indigenous to Europe. Jammu & Kashmir and Himachal Pradesh are the primary growing regions for saffron in India. The Stigma portion of saffron is its commercial component, and it is a member of the Iridaceae family.

The planting season of Saffron is during the months of July to September and is generally harvested in October to November month. About 15000 flowers on drying gives 1kg of saffron. On an average 5 kg dried saffron/ hectare yield can be achieved. Cottage cheese, Biryani's meats, liquors, cordials, cakes, confections, breads, and Mughlai meals all employ saffron as a culinary flavour and to add colour. Commercially, saffron is utilised in cosmetics and perfumes. Saffron is used medicinally to treat fevers, arthritis, impotence, and infertility using Ayurveda medicine. In India, it is thought that pregnant women who consume saffron along with milk will have babies who are a healthy shade of blue.

In India, Jammu and Kashmir is the major saffron production state. Some common names of saffron are Zafran (Bengali, Punjabi, Urdu), Kesar (Hindi), Kumkuma poove (South states).

Summary

Without human involvement, saffron cannot be produced in its modern form. Because the seeds that its flowers generate are sterile, there can be no natural pollination. Via vegetative propagation, the plant reproduces asexually. Corms, which resemble bulbous stems and grow underground, are used for cultivation. Summer is when corms are sown, and mid- to late-autumn is when the saffron crocus blossoms are ready for harvest. In order to prevent them from being harmed by direct sunlight, the incredibly delicate blossoms must be manually plucked before or right after daybreak. Saffron is a very time-consuming crop that needs a lot of attentive work and manual labour. Just three stigmas are produced per bloom. After the flowers are picked, their stigmas need to be removed and dried for about 12 hours.

Commercial agriculture significantly contributes to a nation's economic growth. With a contribution of about 18% of the GDP and 43% of the country's total area, agriculture is thought to be the foundation of the Indian economy. Thus, there is a pressing need to exploit agriculture's economic potential. This can be accomplished by increasing the production of crops with strong economic potential, such as saffron. An economy like India can benefit greatly from the cultivation of saffron.

Saffron cultivation in India has been steadily declining for a variety of reasons. From about 10 MT in 2011 to 6 MT in 2019, saffron production fell. In the midst of this situation, researchers from the Uttar Banga Krishi Vishwavidalaya (UBKV) in Cooch Behar have been working on a pilot project to grow saffron in the Darjeeling Hills. The programme has now produced the expected results. Near Darjeeling town, in the Lebong Valley, was grown high- quality saffron, which is typically grown only in a few regions of Jammu and Kashmir.

Experts predict that saffron could replace tea as the most valuable cash crop in the Darjeeling Hills if all goes according to plan.

In 2021, Dr. Ashok Saha selected seven places of different altitudes in the Darjeeling Hills and planted saffron corms (a bulb-like structure from which the plant grows). These places included Tumling (9600 ft), Maneybhanjyang (7053 ft), Batasia (around 6850 ft), Darjeeling town (6709 ft), and Lebong Valley (5900 ft.) The team visited all the spots this year between September 15 and 20. The plants had not flowered in any of the locations, except at Lebong valley near Darjeeling town. Dr. Saha's team had planted 10 corms at Lebong on two very small plots, measuring 1m X 1.5m each and members of the team were overjoyed when they got around 42 flowers from those 10 corms. The flower's stigma is incidentally used as a spice. The blooms cultivated at Lebong have 2.5 cm sized stigmas, and anything larger than 2 cm is thought to be a high quality spice. The Kurseong Ambotia area has seen an increase in corm planting this year. In September typically, the corms are sown. In October, the blooms blossom. The plants require little maintenance. Nonetheless, it must be ensured that the water is not stagnant. To make sure that growth is not constrained, weeding is also crucial.

Soil and Climate Requirements for Saffron Cultivation

In the farming of saffron, the kind of soil is more crucial than the climate of the region. Saffron may be grown above 2000 metres above mean sea level and does best in warm subtropical climates. The ideal amount of sunlight is 12 hours. The Saffron crop's ability to flower is impacted by low temperatures and high humidity during the flowering season, while spring showers encourage the growth of new corms. Saffron thrives on gravelly, loamy, sandy, acidic to neutral soil types. The ideal soil pH range for saffron farming is PH 6 to 8, and heavy clay soils must be avoided as they are unsuitable. It also requires well-drained soils**.**

Before planting corms, the soil must be made weed-free and replenished with organic matter. A few coughings are needed to get the soil to a fine tilth level, and soil loosening is necessary for better growth. Saffron grows best from June to September, and flowering begins in October of the year it is planted. Typically, leaves begin to dry out around May and vegetative growth begins in the winter. Saffron corms can be sown in pots or straight in the field (indoors and outdoors). Corms should be planted between 10 and 12 cm apart, at a depth of 12 to 15 cm. While irrigation is not required nonetheless, depending on the soil moisture content, it can be done in cases of protracted drought and hot weather. Saffron corms typically multiply from year to year, producing 5 corms from 1 corm after 3 years of planting.

Fertilisers

Before planting, farmers should spread roughly 35 tonnes of farmyard manure on the ground. Autumn and again right after flowering are advantageous times to apply 20 kg N, 30 kg K and 80 kg P per ha of fertiliser annually.

Pests and Diseases Observed

Three primary illnesses are present. Saffron was found to have Fusarium, Rhizoctonia crocorum, and Violet root rot. It is advised to wait 8 to 10 years before using the same pitch again.

Harvesting and Drying of Saffron

Flowering in the saffron industry begins in October and lasts for a month. After the flowers are fully bloomed, harvesting should be done, and morning picking is advised. Take the red pistils out of the flowers after you've harvested them.

Placing the pistils on a sieve in a well-ventilated area between 45° and 60°C for 15 minutes will allow the filaments to dry (well-ventilated food dryer, in an oven with the door slightly open, under the sun outside), Saffron is generally tasteless while it is fresh, so it is advised to store dried saffron in an airtight container away from light for at least one month before using.

Conclusion

The Darjeeling hills' economic situation may change thanks to the most lucrative cash crop: saffron. Depending on the grade, quality—organic or not—and quantity, Kashmir saffron can cost anywhere from Rs 400 to Rs 1000 per gramme. Everyone is optimistic and thinks Darjeeling may join other saffron-producing regions on the world map if the Government of West Bengal, UBKV, and farmers' organisations and associations work together.

Photos


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Floral Freeze Drying: A Gateway of Novel Processing Technology

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Dr. E. Shirin Hima Bindu[1]
[1]Assistant Professor, Department of RMCS, College of Community Science, PJTSAU, Saifabad, Hyderabad-04, Telangana.

Floral design or flower arrangement is the art of using plant materials and flowers to create an aesthetic and balanced composition or display. Flowers near to natural, preserved and processed, have beauty and an everlasting value. For any occasion, dried flowers can be treasured all year long. Innovate and diverse products like bouquets, floral arrangements, flower balls, cards, potpourri, and more are made with dry flowers. The various techniques used for flower drying are Dessicants drying, Sun drying, Hot air oven drying, Micro wave drying, Air drying, Glycerin drying and Freeze drying.

Importance of Floral Freeze-Drying Technology

1. This is an unexplored area in Flower Preservation Process in India for commercialization where application of Freeze-Drying Technology for Dehydration of flowers is done using Floral Freeze Dryers.
2. A Freeze-Drying Process for Floral Preservation is pioneering research in India for production of value-added ornamental flowers, which combines science and art.
3. This is an innovative processing technology which is bio-degradable, ever-fresh, environmentally friendly, flexible for all seasons works with Freeze drying Process.
4. Now is the time for commercial venture to consumer market with creative gifts for all occasions, Interior décor for attracting High-end customers Inland and Abroad.
5. This is an opportunity for Floriculturists and women entrepreneurs to enter into Floral art and Craft business.

Concept of Freeze-Drying Technology for Flower Preservation

The basic principle of freeze-drying is to extract water from produces as water vapour and collect it in a condenser. Shrinkage is avoided or reduced because the products are kept firmly frozen throughout the procedure, which produces preservation that is almost flawless. The elimination of moisture re-entry is frequently the only prerequisite for long-term storage of freeze-dried materials.

Flower is one of the most frequently used perishable products in our daily lives and it plays a significant role in interior décor. Flowers cannot be retained as fresh cut flower or cut foliage for longer duration. However, the charms and beauty of these can be maintained for months to years by employing the most effective (realistic) method of flower preservation through freeze drying.

The process involved in preservation is unique from the conventional methods and floral freeze drying involves specialized equipment and processing. Hydrated flowers are pre-treated with organic chemicals prior to freeze drying process. Use of chemicals in pre-preservation process retains the colour pigment and structural cells intact and thus the flowers look true to life. Freeze-drying is the only way that water can be successfully removed from an organic substance and many other materials without damage to the cell structure and loss of volatile components. The ability to create a freeze-dried flower that has the stunning colour and shape of a fresh flower has been a phenomenon that can create a successful business chance worldwide.

Although, dry flower production is a smaller component of Indian floriculture industry, but the Indian dried flowers and plants are now in high demand worldwide, somewhat at the cost of fresh flowers. The organized research and production of dry flowers in the country can further trigger the growth of floriculture industry.

Enterprise on production of freeze-dried flowers can be an outbreak in flower preservation technology. Extending this knowledge and soft skill to entrepreneurs especially to women for production of freeze-dried flowers can enhance opportunity to explore new methods of promoting domestic and export market.

Freeze dried floral products are useful accessories in interiors of homes, offices, hospitals, business centers. They can meet the needs of personalized gifts for any occasion. These can commercially attract large number of customers for meeting of residential and commercial needs.

How does this Technology Build Business Interest?

1. Value-added Floriculture is rapidly expanding area of Indian agriculture, primarily in response to the ever-increasing demand for flowers in the domestic and export markets.
2. At present dry flower industry is growing very fast with more than 60 per cent share to the floriculture industry in India. There is an unlimited prospect in this field and only with sustained efforts; this can make a significant presence in the world market. Therefore, there is a need to tune the techniques of drying of flowers.
3. The export demand is mostly for fresh-cut flowers produced in modern floriculture farms. There is an increasing demand for modern & exotic flowers from individuals or households, institutions and hotels also continue to be the dominant buyers in the market.

Advantages of Floral Freeze Drying

1. Freeze dried flowers provide distinctive indoor decoration. These can be used in wall shadow frame or dome displays, tabletop display and interior accessory décor.
2. Freeze-dried arrangements last a long time and need little maintenance.
3. Freeze dried flowers can find a market potential as it can be used as attractive accents while decorating the interiors for any home, commercial centres and as gift articles for any occasions.
4. Preserved flowers can be a beautiful reminder of our past experiences, if the flowers are professionally preserved, they will look remarkably almost natural and they last for many years.
5. Everlasting dried flowers are becoming increasingly popular among floral enthusiasts around the world.
6. Value-added floriculture is a process of increasing the economic value and consumer appeal of any floricultural commodity.

Future Prospects of Research and Commercialization

1. This technology can be promoted as an Agri-business Technology to small and marginal entrepreneurs to establish good market for freeze dried flowers in Inland and abroad.
2. Incubation center can be developed as an Experiential Learning Programme unit in the University and to establish the business and marketing.
3. IARI, State Agricultural Universities and State Horticulture departments can train farmers to produce good quality of flowers (free from insect attack) for inland and export market
4. Seasonal and exotic good quality flowers can be turned into value-added preserved flowers by farmers for increasing earnings.
5. Industries can come up with new air-tight packing cases made from UV glass and highly transparent acrylic materials for meeting the market demand.

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Transgenic Insect Resistant Crops - Present Status and Future Scope

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B. Sampath Reddy[1], B. N. Chaudhari[2], Ch. Sowmya[3]
[1]M. sc. Entomology, PDKV, Akola
[2]Assistant Professor of Entomology,
College of Agriculture, Nagpur, PDKV, Akola
[3]M. sc.(Ag.) Entomology,
College of Agriculture, Rajendranagar, PJTSAU.

Introduction

What are GM crops? Genetically modified (GM) crops are such crop plants whose genome is modified using genetic engineering techniques. To improve the existing traits or for introduction of a new trait that does not occur naturally in the given crop species. The plants produced by the insertion of specific segments of foreign nucleic acid/gene sequence into its genome using transformation methods (such as *Agrobacterium*-mediated transformation or direct gene transfer) are known as transgenic plants.

Summary

Insect resistant crops – present status: At present there are many transgenic crops for instance Bt cotton which is resistant to bollworm attack, comprises mainly *cry* genes. These genes are extracted from soil bacteria such as *Bacillus thuringiensis* which are highly used for developing insect resistant transgenic crops. The toxins produced by these genes (Bt, ICP, d-endotoxin or crystalline proteins) are soluble in the midgut of an insect by activating proteinases as they contain acidic ph and further they bind to a specific receptor, damaging the epithelial cells of insect gut by creating a pore, ultimately it kills the pest. Apart from cry genes, other insecticidal genes like vip genes which are isolated from *Bacillus thuringiensis* and *Bacillus cereus* encode vegetative insecticidal proteins for deploying in commercialized crops. Moreover, protease inhibitors which produces proteolytic enzymes present in larval gut and insects will inhibit amino acids that are necessary for insect growth and development, among these only three traits are commercialized and these are *cptI* gene from black-eyed pea introduced in cotton, *api* gene from arrow head plant introduced in poplar and *pin II* gene from potato introduced in maize (ISAAA database 2019), used to develop plant resistance against various pests to exemplify this trypsin inhibitor gene extracted from cowpea is used for transforming tobacco plants (Hilder *et al*., 1987). Lastly, alpha amylase inhibitors and lectins are widely functioned as protease inhibitors, interfering insect nutrition and disrupting midgut epithelial cells respectively.

Transgenic insect resistant crops –future prospects: In the coming future there would be modern methods which are alternatively used such as cisgenesis, intragenesis and the most recent one is genome editing that are aimed to eliminate various farmers concerns and uncertainties associated with the past transgenic technology. First of all, cisgenesis technique involves introduction of complete natural gene sequence as well as it includes introns with its native promoter and terminator that is used for genetic modification of crops (Schouten *et al*., 2006) whereas intragenesis involves same crop species desired gene i.e., not from the same gene thus giving novel genetic combination. In addition, genome editing technology, used for stable mutation or removing out or replacing specific gene and sometimes it is used for both knock out and knocking in the genes in target DNA region. Recent advances like CRISPR-CAS9 are used for mediated genome editing, PRIME EDITING for search and replace genome with high accuracy, GENE SILENCING mainly RNA interference approach (RNAi) silence by breaking into smaller fragments of interfering RNA's by transferring specific gene into the host by vector such as *Agrobacterium tumefaciens*.

Conclusions

The genetic engineering of crop species by the introduction of insecticidal genes offered tremendous protection against invasive and destructive crop pests. Despite the deployment of novel technologies in crops to achieve resistance, some of the agriculture pests often develop resistance to insecticidal toxins and devastate the crop production. The durability of resistant traits in plants can be augmented and complemented by new technologies that offer more effective solutions against evolving insect pests. Advances like RNA interference and CRISPR approaches can be used to silence/edit susceptible or negative regulatory alleles of plant immunity genes for developing GM crops for insect resistance.

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Food Engineering and Millet: Innovations for Sustainability

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Ajay Kumar[1], Sachin Ghanghas[1], Sapna Birania[1]
[1]Department of Processing and Food Engineering, COAE&T, CCS Haryana Agricultural University, Hisar.

Millet foods are becoming an increasingly popular and healthy alternative to conventional foods. They offer a range of health benefits, including being rich in nutrients such as dietary fiber, protein, vitamins, and minerals, and being gluten-free. Millets also have a low glycemic index, making them a good choice for people with diabetes or those who are trying to manage their blood sugar levels (Selladurai et al., 2022). Additionally, millets are a great source of dietary fiber, which can promote digestive health and help reduce cholesterol levels. They are also versatile and easy to use in a variety of recipes, from breakfast cereals and snacks to bread, muffins, and desserts. Overall, incorporating millet foods into your diet can provide a range of health benefits and promote overall well-being. Millets can be used to make a variety of healthy and tasty snacks such as crackers, chips, and bars. These snacks are a good alternative to traditional snacks made from refined grains, which are often high in calories and low in nutrients. Additionally, millets can be used to make pasta that is gluten-free and high in fiber, providing a healthier alternative to traditional pasta made from refined flour (Sharma et al., 2021). Millet-based beverages such as millet milk, smoothies, and shakes are becoming more popular, and millets can also be used to make a variety of baked goods such as bread, muffins, and cakes. Millet-based breakfast cereals, including flakes, puffs, and granolas, are also a good source of nutrition. Finally, millets are a good source of nutrition for babies and can be used to make baby food such as cereals, purees, and snacks (Gowda et al., 2022). As a food engineer, one can play an important role in developing and promoting these products to meet the growing demand for healthy and sustainable foods.

In addition, engineering interventions can help improve the post-harvest processing of millets. Technologies such as grain threshers, cleaners, and grinders can be developed to improve the efficiency of millet processing and reduce losses. Furthermore, engineering can help in the development of packaging and storage solutions that prolong the shelf life of millets and prevent contamination. Recent technological advancements in the post-harvest processing of millets have significantly improved the quality, safety, and shelf life of millet products (Powar et al., 2020). Modern grain cleaners and sorters use advanced technologies such as air aspiration, vibration, and magnetic separation to remove impurities and foreign materials from millet grains. New technologies like solar dryers and mechanical dryers have been developed to improve the efficiency of millet drying, while airtight containers, hermetic bags, and metallic silos help prolong the shelf life of millet grains during storage. In the processing stage, modern millet mills use advanced technologies such as dehullers, disc mills, and hammer mills to process millet grains into various products such as flour, grits, and flakes. Furthermore, new packaging solutions like vacuum-sealed bags, airtight containers, and moisture-proof bags have been developed to preserve the quality and freshness of millet products. These technological improvements have not only helped to reduce post-harvest losses but also increased the economic value of millet production (Beta and Ndolo, 2019).

Food engineering plays a crucial role in enhancing the popularity and scaling up of the millet industry. By developing innovative millet-based products, improving the processing and storage of millets, fortifying them with essential nutrients, and developing efficient and sustainable processing technologies, food engineers can increase the appeal, affordability, and accessibility of millet products to consumers (Dekka et al., 2023). The utilization of thermal processing, extrusion, fermentation, and other techniques enhances the nutritional value and shelf life of millet products while reducing waste and increasing yields. Fortifying millet products with essential vitamins and minerals can address micronutrient deficiencies in many populations. Additionally, developing sustainable processing technologies that are cost-effective and environmentally friendly can make millet products more affordable and accessible to consumers (Kumar et al., 2022). Overall, food engineering is a critical component in creating a sustainable and resilient food system, and it can unlock the potential of millets as a key crop for the future.

Millet is a highly nutritious crop with great potential to address food security and malnutrition challenges. However, the millet industry faces several challenges, including low yields, post-harvest losses, and limited processing and storage technologies. Through the application of food engineering, we can develop new and innovative millet-based products, improve processing and storage technologies, fortify products with essential nutrients, and develop efficient and sustainable processing methods.

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Chironji (*Buchanania lanzan*) - The Tree of Wonder

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Errabelli Jahnavi[1], Dr. T. Kamalaja[2]
[1]Research Scholar, Food and Nutrition, PGRC, PJTSAU, Rajendranagar, Hyderabad.
[2]Senior Scientist, AICRP-WIA, Department of Foods and Nutrition, PGRC, PJTSAU, Rajendranagar, Hyderabad.

Introduction

The chironji or charoli tree (*Buchanania lanzan L.*) is a member of the *Anacardiaceae* family which grows in forest environment in tropical regions of North, West and Central India. It is an underutilized fruit provide huge benefits to nations tribal culture. The height of the tree is 40-50 feet and it's bark is rough, dark grey and is reddish inside with a straight trunk. Although it is a very hard tree, but cannot survive under water logged conditions. They exhibit the similar characteristics like mangoes. All the parts of the plants provide huge health benefits.

Leaves

The chironji tree leaves are 6-10 inches long.The. lamina is 10 to 23.5 cm x 5 to 12 cm, with a round base, broad, rectangular (Figure-a).

Flowers

The flowers are small in size with a diameter of 6.11mm. They are greenish-white in colour, in the terminal and axillary pyramidal ferrugineo-pilose panicles. A single panicle contains nearly 3000-5000 flowers. The flowering starts in January to March (Figure-b).

Fruits

This tree bears fruits called Chironji with a single seed in it. Fresh fruits are green in colour and turn to purplish black colour after maturing. The size of the fruits is about 0.4 to 0.6 cm long and 0.3 cm to 0.5cm wide. The fruit ripens in mid-April and ends in mid-June. On an average the tree yields nearly 40-50 kgs of fresh fruits. The fruit is juicy and sweet in taste with a sub acidic flavor. They can be consumed fresh or dried for further use. But the juice content is less because of the large size of the seed. This fruit can be used for preparation of several value-added products i.e., squashes, ready to serve drinks, nectars, desserts and can also be dried and preserved by making into powder (Figure-c).

Seeds

The seeds of the chironji fruits are edible mimic almond flavor and can be eaten in the form of raw or roasted. The tree yields nearly 1 to 5 kgs of seeds. The seeds should be kept in a close container as it loses its flavor and tastes bitter. The seeds are used to make oil and can be replaced with other edible oils and widely used in confectionaries. These are rich in nutrients and have medical properties (Figure-d).

	
Figure-a	**Figure-b**

	
Figure-c	**Figure-d**

Taxonomic Classification

Kingdom	Plantae
Subkingdom	Viridiplantae
Phylum	Tracheophyta
Class	Magnoliopsida
Order	Sapindales
Family	Anacardiaceae
Genus	*Buchanania*
Species	*Lanzan*

Nutritional Benefits of Chironji

Improves Immunity: Chironji seeds are rich in vitamins and minerals. It fights against all kinds of diseases and health problems. These seeds helps in boosting immune system.

Reduces Diarrhea: The roots of the chironji plant have a constipating property. The ethanolic extract of the powder of the roots may reduce the faecal output in-turn it reduce the number of episodes of diarrhea.

Reduces Sugar levels: This seed exhibits anti-diabetic property which plays an essential role in maintaining the blood sugar levels. The ß-pancreatic cells, which helps in the production of insulin become extremely active during the consumption of the seed powder or leaf extract.

Improves Cardiac functioning: The chironji seed powder maintains high significance in strengthening of the heart muscles and lowers cholesterol levels in the blood and prevents lipid build-up, which in turn reduces the risk of atherosclerosis, heart blocks, heart attacks, blood clots.

Treats Wounds and Ulcers: Chironji leaves hold high significance in anti-inflammatory and anti-ulcer properties which is used for treating different types of ulcers like ulcerative colitis, peptic ulcer, or mouth ulcers, etc. The bioactive compounds in the seed powder promotes tissue regeneration and wound healing.

Treats Anaemia: The juice extracted from the seeds (methanolic extracts) may have some effect on blood production from the bone marrow. It may increase the red blood cell and white blood cell count and also the haemoglobin concentration in the blood.

Reduces Stress: Chironji fruits are high in antioxidants and methanolic properties.Due to this characteristics,it help to deal with oxidative stress which is caused by free radical damage.it is very protective against the stress causing factors occurring in the body and reduces the stress related problems.

Helps in Weight Loss: The chironji seeds are rich in proteins,vitamins and low in calories. This can be included in the diet of obesity patients to remove excess fat from their body.The seeds gets digested very slowly so it keeps fuller for long period and in-turn aids to weight loss.

Reduces Skin problems: Chironji seeds have high a quantity of oils and fats, which is used as a good moisturizing agent. The chironji seed oil can be applied to treat acne, pimples on the face. It may be used to reduce the itching and redness in various skin diseases.

Chironji oil may provide moisture (lipid and fats) which are essential for the scalp.It can be applied to the scalp in which it provide moisture and nutrients to the scalp and the hair.It also treats dandruff, itching, and redness of the scalp.

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Engineering Interventions in Food Printing: The Future of Nutritious and Sustainable Food

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Sachin Ghanghas[1], Sapna Birania[1], Ajay Kumar[1], Naveen Sihag[2]
[1]Department of Processing and Food Engineering, COAE&T, CCS Haryana Agricultural University, Hisar.
[2]Department of Genetics and Plant Breeding, COA, CCS Haryana Agricultural University, Hisar.

Food printing, also known as 3D food printing, is an emerging technology that uses digital design files to create three-dimensional edible objects. This technology has the potential to revolutionize the way we prepare and consume food. Food printing, an emerging technology in the food industry, has recently witnessed significant advances in several printing techniques, which rely on the principles of material deposition, layer-by-layer assembly, and precise placement of biological materials. Extrusion-based printing uses a nozzle or syringe to deposit food materials, such as dough, chocolate, and cheese, layer-by-layer to create three-dimensional structures (Kewuyemi et al., 2022). Powder-based printing uses a powder bed and selectively deposited liquid to bind powdered food particles, such as sugar, spices, and fruits, together. Inkjet-based printing sprays tiny droplets of edible material, such as food dyes, flavourings, and living cells, onto a printing surface to create the desired shape. Laser-based printing uses a laser to fuse food materials, such as chocolate, selectively and precisely. Finally, magnetic 3D bioprinting manipulates living cells and biological materials, allowing for the creation of complex structures with precise cell placement (Kumari et al., 2021). These recent advancements in food printing offer immense potential in various areas, including personalized nutrition, waste reduction, and novel culinary experiences, and could significantly impact the future of the food industry. The nutritional comparison between printed foods and raw foods can vary depending on the specific food and its preparation method (Zhang et al., 2022). Generally, raw foods tend to be higher in certain nutrients, such as vitamins and minerals, than processed or cooked foods. However, food printing technology can offer certain benefits over traditional food preparation methods, such as the ability to create customized nutritional profiles and tailor food to specific dietary needs.

The engineering interventions in printed foods can play a crucial role in enhancing the quality, texture, and nutritional value of printed foods. Texturization of printed foods can be achieved by changing the extrusion rate and nozzle size, creating intricate designs and textures that improve the eating experience. Encapsulation is another engineering intervention that can be used to enhance the flavour and nutritional content of printed foods by adding encapsulated flavours and vitamins (Juliano and Reyes-De-Corcuera, 2022). This also protects sensitive ingredients from environmental factors and extends the shelf life of the food. Customization is another key benefit of food printing technology, as it allows for the creation of personalized nutrition plans tailored to individual dietary needs. By adding specific nutrients, vitamins, and minerals to printed foods, food printers can create foods that meet the nutritional requirements of specific individuals, such as athletes or people with dietary restrictions (Varvara et al., 2021). Additionally, composite printing can be used to create complex structures that incorporate multiple food materials, such as meat and vegetables, or different types of dough. This can create new food experiences and textures, as well as increase the nutritional content of the food. Finally, nanotechnology can be applied in food printing to create new food structures that have improved texture and flavour, as well as increased nutritional value. For example, nano-emulsions can be added to printed foods to improve their flavour and texture. Other nanotechnology applications include the use of nano-particles to create functional foods that can prevent chronic diseases, such as diabetes and cancer (dos Santos et al., 2021).

In conclusion, food printing technology is an innovative approach that has the potential to transform the food industry by offering customized, nutritious, and sustainable foods. The engineering interventions in printed foods, such as texturization, encapsulation, customization, composite printing, and nanotechnology, can significantly enhance the quality, texture, and nutritional value of printed foods, as well as create new culinary experiences and meet specific dietary needs. While the technology is still in its early stages, the rapid advancements in food printing technology and the increasing demand for healthy and sustainable foods suggest that food printing is likely to play a significant role in the food industry in the coming years. With the potential to create personalized nutrition plans, reduce food waste, and improve the nutritional value of foods, food printing technology holds promise for addressing some of the key challenges facing the food industry today.

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Advances in Production Technologies for Pulses in Tamil Nadu

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S. Anitta Fanish[1]
[1]Assistant Professor, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu.

Pulses are a very important crop for India. They are an important source of protein, grow quickly, generate good profits for farmers, and contribute to agricultural and environmental sustainability. Pulses belong to the legume family, which includes plants whose fruit grows in a pod, such as peanuts, soybeans, and green peas. Yet none of those foods are pulses. The term "pulse" refers strictly to dried seeds. Of all categories of people, pulses form an integral part of the Indian diet, providing much-needed protein to the carbohydrate-rich diet. India is the largest producer of pulses in the world. Pulses are 20 to 25 percent protein by weight which is double the protein content of wheat and three times that of rice. Dietary allowance recommended for adult male is 60 gm per day and for adult female it is 55 gm per day (Directorate of pulses Development, 2016). However, the per capita availability is only 42 gm per day. It calls for all out efforts to increase the per capita availability of Pulses. India has achieved first rank in World area (35 %) and production (25%) under Pulses; India has an area of about 25 million ha of Pulses producing 16.5 million tonnes of Pulses. This is 35% percent of the world area and 25% of world production. However, the average yield level in India is 650 kg/ha against the world average of 909 kg/ha. In Tamil Nadu, pulses are cultivated in 8 lakh ha to produce 4.73 lakh tonnes and the average yield level (589 kg /ha) is far below the national average. Hence, efforts are needed to increase the productivity of Pulses in Tamil Nadu. Some of the important advanced production technologies for enhancing pulses production in Tamil Nadu are summarised below.

Suitable Season and Varieties

Crop	Season	Variety
Red gram	Adipattam	CO 8 , CO9
	Purattasipattam	Co (Rg) 7 and VBN(Rg) 3
Black gram	Adipattam	VBN 8, VBN 11
	Puratasipattam	MDU 1, CO 6, VBN 8, VBN 10 , CO7, VBN 11
	Rice fallows	ADT 6, KKM 1, VBN 6, VBN 9
	Chithiraipattam	ADT 5, VBN 8
Green gram	All season	CO(Gg) 7, CO 8, VBN 4
	Rice fallow	ADT 3
Cowpea	Adipattam	CO (CP) 7
	Purattasipattam & Thaipattam	CO (CP) 7 , VBN 3
Bengal gram	Winter season	Jaki 9218, CO 4
Horse gram	Winter season	Paiyur 2

Seed Treatment / Inoculation

Seed treatment with fungicides to prevent seed borne diseases and seed inoculation with Rhizobium and phosphate solubilising bacteria (PSB) to enhance nitrogen fixation and availability of Phosphorus before sowing. First treat the seeds with talc formulation of *Trichoderma viride* @ 4g / kg of seed (or) *Bacillus subtilis*@ 10 g / kg seed. Then, treat the seeds required for sowing 1 ha with 200g each of *Rhizobial* culture, Phosphobacteria and PGPR (Pseudomonas sp.) using rice gruel, shade dry it before sowing.

Sowing parameters: Seed should be pure, free from disease and physical damage with 95% viability. The details of sowing parameters are as follow. Spacing, seed rate and sowing of different pulse crop:

Crop	Seed rate (kg /ha)	Spacing	Sowing time
Red gram	8	Long Duration - 120 x 30 cm	Kharif (July – August)
	13	Short duration - 45 cm x 30 cm	Rabi, summer
Black gram	20	30 x 10 cm	Kharif, Rabi, Summer irrigated
Green gram	20	30 x 10 cm	Kharif, Rabi, Summer irrigated
Cowpea	25	CO(CP) 7 - 45 x 15 cm	Kharif
		VBN 3 - 30 x 15 cm	
Horse gram	20	30 x 10 cm	Rabi
Bengal gram	75	30 x 10 cm	Rabi

Balanced Fertilization

Phosphorus is an important element for increasing the yield of pulses. Its beneficial effect on nodulation, growth, yield and general performance of legume crops is already established. For getting good yields of different pulses, 25: 50: 25 : 20 kg of nitrogen, phosphorus, potassium and sulphur per hectare should be applied as a basal dose at the time of sowing of the crop. Along with soil application of 25 kg $ZnSO_4$ / ha under irrigated condition. For micro nutrient deficit soils, application of TNAU micronutrient mixture @ 5 kg/ha as Enriched FYM (Prepare enriched FYM at 1:10 ratio of MN mixture & FYM ; mix at friable moisture &incubate for one month in shade) is recommended.

Weed Management

Weed competition during first 30-60 days of the crop is very sensitive therefore weed control is very essential during these stages. The effective weed management in pulses achieved by adapting the integrated weed management are as follows. Pre emergence application of Pendimethalin @ 1.0 litres / ha under irrigated condition or PE application of Pendimethalin 0.75 litres per hectare under rainfed condition on 3 days after sowing using Backpack/ Knapsack/Rocker sprayer fitted with flat fan nozzle using 500 litres of water for spraying one ha. After this, one hand weeding on 30th days after sowing gives weed free environment throughout the crop period. (or) EPOE application of quizalofop ethyl @ 50 g ai / ha and imazethapyr @ 50 g ai / ha on 15 – 20 DAS. If herbicide is not applied give two hand weedings on 15 and 30 days after sowing. Apply Pendimethalin 30% EC + Imazethapyr 2% EC (Valor 32% EC; Readymix herbicide) @ 1.0 kg a.i. / ha at 3 DAS. Otherwise apply metalachlor 1.0 kg / ha on 3 DAS followed by one hand weeding on 40 DAS.

Water Management

Irrigate immediately after sowing, followed by life irrigation on third day. Irrigate at intervals of 7 to 10 days depending upon soil and climatic conditions. Irrigation should be avoided during active flowering period otherwise flower shedding and reversion to vegetative growth may occur. Avoid water stagnation at all stages. Good drainage facilities should be provided for higher yield.

Foliar Nutrition

Foliar nutrition is a technique of feeding plants by applying liquid fertilizer directly to their leaves. Plants are able to absorb essential elements through their leaves. Under reduced soil nutrient availability and root activity condition, foliar nutrition plays a vital role for getting more yield per unit area. Plants are able to absorb the nutrients through their stomata rapidly after the application. For pulses like red gram, horsegram, blackgram, greengram, foliar nutrients can be applied.

Preparation of Different Foliar Sprays

TNAU pulse wonder: The dosage of application is 5 kg/ha with spray volume of 500 litres. The spraying has to be done at peak flowering. By spraying pulse wonder, the flower shedding decreases and the yield increases upto 20 %.

2% DAP: For one ha, 5kg of DAP has to be soaked in 25 litres of water for 24 hrs in a plastic bucket or earthen pot. Metal pot should be avoided. After 24 hrs the whole content has to be sieved through a muslin cloth. Then the solution is mixed with 475 litres of water with final volume of 500 litres for 1 ha. Knapsack sprayer has to be used for spraying. First spray has to be done at flowering and 2nd at 15 days after 1st spray.

NAA and Salicylic acid: Foliar spray of NAA 40 mg/l and Salicylic acid 100 mg/l once at flowering at 15 days after 1st spraying can be done. It regulates the growth and increases crop yield.

Method of application: The foliar application has to be done during flowering stage. Response of the crop to foliar nutrition is excellent when the crop is at stress free condition. Foliar application is not effective, if followed by stress; whether heat or moisture stress. So there should not be any moisture stress before, during and after the application of foliar spray. Foliar spray has to be done either during late evening i.e. after 6 p.m. or else it has to be done at early morning i.e. before 9 a.m. The spraying should be done when wind speed is lesser to reduce the losses.

Plant protection measure: Timely adoption of plant protection measure is very important. Pulses mostly grown by farmers are without any plant protection measures. Therefore, the yields are very low. Crops like greengram, blackgram and cowpea suffers from yellow mosaic which is a virus disease and also attacked by pod eating caterpillars. All the pest and diseases greatly reduce pulses yields. Therefore, it is very essential to provide need-based plant protection measures in order to obtain higher yields.

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Management of Insect-pest of Cowpea (*Vigna ungiculata*)

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Prince Sahu[1], Rajat Singh[2]
[1]Research Scholar, Department of Entomology; Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.).
[2]Research Scholar, Department of Vegetable Science; Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.).

Introduction

One of the most significant legume crops, also known as lobia and a member of the Leguminaceae family, is the cowpea (*Vigna unguiculata* Linn.). It is utilized as a green manure crop, vegetable, feed, and legume. The cowpea plant is typically upright, with smooth trifoliate leaves grouped alternately on the stalks and ribbed stems. Cowpea seeds are a strong source of lysine and tryptophane, as well as 23.4 percent protein, 18 percent fat, and 60.3% carbohydrates (Singh, 1983). Pulses are produced on roughly 25.26 lakh hectares of land in India, with a production of 16.47 million tonnes in the 2015–16 fiscal year. Cowpea is cultivated throughout the India and the major growing states are Karnataka, Andhra Pradesh, U.P., Bihar, Punjab, Haryana, Rajasthan and Madhya Pradesh. Cowpea plays a significant role in Bihar due to their short lifespan, high yield, and rapid growth rates, as well as their high protein content. The crop is also noted for quickly covering the land, which aids in soil preservation. Nalanda, Bhojpur, Vaishali, Muzaffarpur, Samastipur, East Champaran, and West Champaran districts in Bihar are the main cowpea-growing regions. These cowpeas are mostly farmed for vegetables and grains, with a lesser amount also being produced as a fodder crop. It has good nutritional characteristics and is well adaptable to stress. Because to its smothering nature, drought tolerance, and soil properties, it is one of the most adaptable pulse crops.

Pests of Cowpea

Legume Pod Borer (*Maruca testululis***)**

Distribution and Importance: *Maruca* is widely distributed throughout the tropics and sub-tropics where it may cause extreme damage. It is a major cowpea pest in Africa and Southeast Asia.

Biology and Damage: The adult, a nocturnal moth with pale patterns on its forewings, is light brown in colour. The larva is light brown in colour with erratic brown-black head, lateral, and ventral patches. Eggs are laid by adult moths, which have a lifespan of up to a week, on leaf buds, flower buds, and in flowers. The larvae feed on the delicate stem, peduncle, flower buds, flowers, and pods after the eggs hatch in around 5 days. Webbing of flowers, pods, and leaves as well as the development of frass on pods are telltale evidence of larval feeding. Pods must be kept apart in space; places of contact between pods and between pods and leaves are particularly vulnerable to injury. Each female lays around 150 eggs. The pupal stage lasts 5-7 days before adults' hatch.

Management:

a. ETL: 3/plant
b. Phosalone 0.07% (Spray fluid 625 ml/ha). Note: When the activity of coccinellid predator (both grubs and adults) is seen, insecticide application should be avoided.

Cowpea Aphid (*Aphis craccivora)*

Distribution and Importance: *Aphis craccivora* is an important legume pest of Asia and recent observations suggest that aphids may also be seasonally important in parts of Africa. This species of aphid not only causes direct damage to its hosts (including groundnut as well as cowpea) but also transmits cowpea aphid-borne mosaic virus.

Biology and Damage: *A. craccivora* is a shiny, black, medium-sized aphid with a variable biology based on soil and environment. A generation could finish in as little as 13 days under ideal circumstances. Adults have a lifespan of 6 to 15 days and can have more than 100 offspring. Aphids typically feed on the underside of young leaves, on immature stem tissue, and on mature plant pods when feeding on cowpeas. They inflict direct feeding harm when they are present in large quantities. Stunted growth in the plants causes distorted leaves, early defoliation, and seedling death. The spread of the cowpea aphid-borne mosaic virus has an indirect and generally more detrimental effect, even in tiny populations.

Management:

a. ETL: 20/2.5 cm shoot length
b. Spray any one of the following (Spray fluid 250 l /ha):
   i. Methyl demeton 25 EC 500 ml/ha
   ii. Dimethoate 30 EC 500 ml/ha.

Gram Pod Borer: *Helicoverpa armigera*

Symptoms of damage:

a. Defoliation in early stages
b. Larva's head alone thrust inside the pods and the rest of the body hanging out.
c. Pods with round holes.

Identification of the pest:

Eggs – are spherical in shape and creamy white in colour, laid singly
Larva – shows colour variation from greenish to brown. Green with dark brown grey lines laterallyon the body with lateral white lines and also has dark and pale bands.
Pupa – brown in colour, occurs in soil, leaf, pod and crop debris
Adult - light pale brownish yellow stout moth. Fore wing grey to pale brown with V shaped speck. Hind wings are pale smoky white with a broad blackish outer margin.

Management:

a. ETL: 5-6 eggs or 2-3 small larvae / plant
b. Bird perches @ 50 / ha
c. Set up light trap
d. Pheromone traps @ 12 / ha
e. NPV @ 250 LE / ha + 0.1 % teepol
f. Apply any one of the following insecticides:
g. Azadirachtin 0.03 % WSP 2500-5000 g/ha
h. *Bacillus thuringiensis* serovarkurstaki (3a,3b,3c) 5%WP1000-1250 g/ha
i. Dimethoate 30% EC 1237 ml/ha
j. Emamectin benzoate 5% SG 220 g/ha
k. Indoxacarb 15.8% SC 333 ml/ha
l. Chlorantraniliprole 18.5 SC 150ml/ha
j. Spinosad 45%SC 125-162 ml/ha
l. NSKE 5% twice followed by triazophos 0.05%
m. Neem oil 2%.

Whitefly: *Bemisia tabaci*

Symptoms of damage:

a. Leave mottled and yellowish in colour.
b. vector of yellow mosaic virus.

Identification of the pest:

Adults -are small, yellow bodied insects with white wings which are densely covered with a waxy powder.

Nymphs and pupae -are black and round or oval. Pupae have marginal bristles

Management of sucking pests:

a. Shaking the infested plants over the vessels of oil and water or oily cloth gives most effective.
b. Spray methyl demeton 25 EC 500ml or dimethoate 30 EC 500 ml or phosphomidon 85 WSC 250 ml/ha.

Leaf Hopper: *Empoasca kerri*

Symptoms of damage:

a. Leave mottled and yellowish in colour.
b. Green colour insects found under surface of leaves.

Identification of the pest: Adult – elongate, active, wedge shape, green insects.

Management: Spray the infested crop with methyl demeton 750 ml in 700 - 1000 L water per hectare.

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Promotion of Agricultural Drone Technology: Role of Government and Institutions

Article ID: 40788

Kumari Nisha[1], Ajay Kumar[1], Sachin Ghanghas[1]
[1]College of Agricultural Engineering & Technology, Chaudhary Charan Singh Haryana Agricultural University, Hisar.

According to a global study, due to pesticides, around 44% of the world's farmers, each year have been affected. The same study showed that pesticide poisoning kills 11,000 people per year and affects 385 million people, the majority of whom are farmers and agricultural workers. Approximately 60% of the fatalities, or 6,600 deaths per year, occur in India alone (Boedeker *et al.*, 2020). The advent of drone technology in the last decade has enhanced the potential to accurately solve problems in agriculture. In recent years, Small UAVs (agricultural drones) have also begun to gain popularity as they can easily carry out multiple activities like spraying pesticides, nutrient applications, taking farm images using GPS technology, disease detection, providing inputs regarding the level of water, and so on. Drones can also enhance field operations in the areas of spraying, irrigation, soil, and crop health, and field analysis by reducing human fatigue, and drudgery, as well as also help in the efficient use of manpower, elevates productivity, and improves quality. Drone applications could not be popularised in India due to a lack of technical knowledge and higher initial investment. As a result, new technological strategies for farmers must be introduced and better implemented.

According to a recent World Economic Forum (WEF) report, drones have the potential to be at the center of a technology-led transformation of Indian agriculture, increasing the country's GDP by 1-1.5 percent and creating at least five lakh new jobs. The Agriculture Ministry is offering incentives to agricultural institutions for the procurement of drones and has developed standard operating procedures (SOPs) for using drones to apply pesticides and nutrients.

The central government, on the other hand, supports drone schemes to assist farmers with crop appraisal, land record digitization, and other various applications. The country still has to develop more supportive policy and regulatory frameworks, generate and disseminate suitable technology, improve support services and increase social inclusion, enhance physical infrastructure and social services, develop non-farm income-earning opportunities, and strengthen financial stabilization. The government has come out with the Production-Linked Incentive (PLI) scheme for the promotion of the drone industry in India. For the first time, the PLI scheme was brought about for an industry that was in a nascent stage. A Rs 120 crore incentive is included in the PLI scheme for the drone industry, which in 2021 had a mere Rs 60 crore in revenue. The government is generating demand for drones and has mandated the use of drone technology in 12 ministries, including agriculture (Anonymous, 2021).

Guidelines Issued by the Government

1. The guidelines of "Sub-Mission on Agricultural Mechanization" (SMAM) have been amended: A subsidy of up to Rs. 10 lakhs or 100% of the cost of agricultural drones, whichever is less, may be given to Farm Machinery Testing & Training Institutes, ICAR institutions, Krishi Vigyan Kendra's (KVK's), and State Agriculture Universities to purchase drones.

2. The Farmers Producers Organizations (FPOs): Would be qualified for funding worth up to 75% of the cost of the agricultural drone for its field trials.

3. A contingency expenditure:

a. Implementing organizations that choose to hire drones instead of buying them from drone manufacturers, custom hiring centers, start-ups, and hi-tech hubs will receive Rs. 6000 per acre.
b. The contingent cost to implementing organizations for drone purchases for drone demonstrations would be capped at Rs. 3000 per hectare.
c. Financial aid and grants would remain accessible until March 31, 2023.

4. To provide agricultural services through drone application:

d. Existing Custom Hiring Centers that were established by the Cooperative Society of Farmers, FPOs, and Rural Entrepreneurs would be eligible for financial help for the purchase of drones up to 40% of the base cost of the drone and its attachments, or Rs. 4 lakhs, whichever is less.

e. Drones can be included as one of the devices together with other agricultural machinery in the projects of CHCs/Hi-tech Hubs that will be built by the cooperative societies of farmers, FPOs, and rural entrepreneurs with financial assistance from SMAM, RKVY, or any other Schemes.

5. Agriculture graduates establishing Custom Hiring Centers:

f. They would be qualified to receive up to Rs. 5 lakhs in grant support for drone purchases or 50% of the basic cost of the drone and its attachments.

g. Rural business owners should possess a remote pilot license from an institute indicated by the Director General of Civil Aviation (DGCA) or from any authorized remote pilot training organization. They also have passed a class tenth examination, or its equivalent, from a recognized Board.

State Bank of India (SBI) and drone manufacturer IoTech World Avigation Pvt. Ltd. have come together to provide agri-drones to farmers at affordable prices and low loans. SBI will provide loans at the market rate to the customers of IoTech World Aviation without any mortgage, a three percent concession in interest. This exemption will be given under the Agriculture Infrastructure Fund (AIF) of the Government of India.

Based on the aforementioned viewpoint, it can be said that the agriculture drone regulatory frameworks have been proven to be a positive approach in terms of the importance of the growth of the agricultural field in India, and they should be best suited and prepared for the growth of the Indian agriculture setup. Hence, need-based research is required for the complete popularization and adoption of drone technology in an efficient and appropriate method to enhance the drone's performance, including the proper implementation of several schemes. It was concluded that, because the concept is still in its early stages, new regulations and specialized personnel are needed to work on the implementation of drone technology in agriculture, and farmer and legislator responses should be analyzed.

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Spawn Production Technology of Oyster Mushroom

Article ID: 40760

Partha Mondal[1], Bikram Saha[1]
[1]B.sc (Hons) Agriculture, Lovely Professional University, Punjab.

Introduction

Mushrooms are a reliable and rich source of unconventional food protein to the health concern population of today's world. Mushrooms have been an integral component of the evolution of Indian agriculture from being conventional and non-commercial to a competent modernized business sector.

Mushrooms can be grown commercially through spawns. Spawns are mushroom seeds that are available in the Directorate of Agriculture and State Agricultural Universities (SAUs). They consist of mycelia of the fungus multiplied on suitable substrates like cereal grains. Spawn in the mushroom industry means the planting material that provides the backbone to any mushroom growing operation.

For optimum yield of mushroom, quality spawn should be used. That's why preparation of good quality spawn is essential in mushroom industry.

Spawn Production Technology

The mycelia of mushroom fungus cannot be propagated as such; hence the mycelia are multiplied on a carrier like cereal grains. Like in all other crop production systems, seed or spawn is the key input in mushroom cultivation. Non-availability of quality spawn is the major constraint in mushroom production. Good quality spawn conforms to,

1. High yield potential,
2. Absence of contaminants,
3. Better economic benefit.

Prerequisites of Spawn Production

A good source of fruit body supplies and laboratory conditions for a sterile environment are needed. The process requires special technical skill and a laboratory for quality and economic spawn production. The basic steps involved in spawn production are:

1. Pure culture preparation
2. Mother spawn preparation
3. Commercial spawn preparation.

Pure Culture/ Nucleus Culture Preparation

Pure culture of mushroom species can be obtained either by spore culture or tissue culture. Although mushrooms are spore bearing fruit bodies of macro fungi, all spores are seldom vigorous and the pure cultures obtained show variations because of genetical reasons. In tissue culture, a well grown mushroom fruit body devoid of any disease is collected. The fruit body is longitudinally split open into two halves. A small section of tissue from the inside of the junction area of the pileus/cap and stalk is taken aseptically with forceps and placed over potato dextrose agar (PDA) or malt extract agar (MEA) media in slants or petri plates. These are incubated at 25±2°C and after a week's time the tissue generates mycelium which cover up the entire media surface and the cultures become ready. The first-generation pure culture prepared from mushroom fruiting body tissue is called mother culture

Mother Spawn Preparation

Criteria for base material selection along with the steps involved in spawn preparation are: Jowar (sorghum) and bajra (pearl millet) are considered best as spawn substrate, while wheat is the next best cereal. Bacterial contamination of spawn is less in paddy grains as compared to wheat. This is due to presence of a harder husk in paddy. Maize grains are also abundantly available in the hilly areas and serve as very good base material. Maize grain is one of the best substrates to be used for mother spawn production. However, maize grains are not preferred for planting spawn due to bigger size and less surface area. There is a negative correlation between the protein content of grain used for spawn and the yieldof mushroom. The protein content of paddy is 7% and that of wheat is 12%. However, wheat is the best substrate for button mushroom spawn.

1. The suitable substrate is prepared by cleaning, washing and cooking for about thirty minutes. After draining off the excess water, 5g pharmaceutical grade calcium carbonate (CaCO3) and 20g Gypsum (CaSO4· 2H2O) is mixed with per kg of the cooked cereal grain. The grains are coated with CaCO3 to raise the pH above 7; to accelerate the growth of the spawn.
2. The processed substrate is either filled polypropylene bags (6x8 inch. size) to hold 200g/bag for mother spawn. The open end of the bags is plugged with cotton plugs.
3. The filled bags are then sterilized in an autoclave at 121oC (15 lb pressure/sq. inches) for about 1-1½ h.
4. The nucleus culture is then cut using a sterilized inoculation needle and the cut portionis transferred into the polypropylene bags and the bags are then again sealed using cotton plugs and rubber bands and are labelled properly with species name, generation and date.
5. The mother spawn bags are then incubated in a clean room under room temperature for mycelial development.
6. After 15-20 days, mycelium growth will be observed and this can be used for commercial spawn preparation.

Commercial Spawn Preparation

1. The treated-grain fill bags are sterilized in autoclave or pressure cooker at 15 psi and all the instruments are kept inside laminar flow chamber and UV light is turned on for 20 minutes.
2. In laminar flow chamber, 10 g mother spawn is transferred to treated-grain fill bags using a spatula and bags were sealed using cotton plugs and rubber bands and are labelled properly with species name, generation and date.
3. Then, the commercial spawn bags are incubated in a clean room under room temperature for mycelial development.

Storage

Temperature of 25±2ºC or at room temperature spawn can be stored up to 30 days, from the date of inoculation. Under refrigerator conditions, spawn can be stored for another 320 months. However, there will be some decrease in yield of mushroom with increased storage time above 2 months.

Contamination and Spoilage

Growth of the mycelia gets restricted in the substrate when bacteria or moulds over grow the mycelia and the spawn is gets contaminated or get spoilt. Bacterial contamination in spawn packets is generally found as patches of slimy fluid on the substrate where the mycelium growth ceases. Spoilage caused by the moulds Aspergillus sp., Pencilliun sp., Rhizopus stolonifer and Trichoderma sp., can be seen when the substrate has patches andat times much of it colonized with different coloured mycelia or spores other than white. The factors like excess moisture in the grains, bad quality grains, improper sterilization and high temperature during storage contribute to spoilage of spawn.

Desired Traits of Spawns

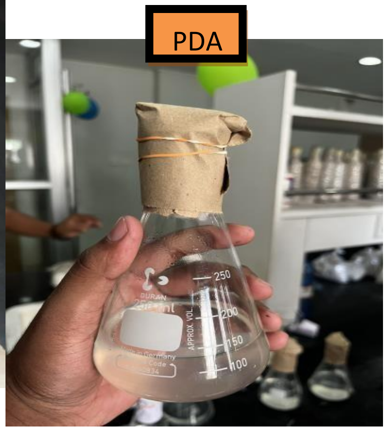
Spawn should always be procured from reliable and authentic sources as it is the key input for successful mushroom production. Time, labour and money are lost when good quality spawn is not used for planting. While procuring spawn few things are to be taken care of like the species of mushroom, generation and date of inoculation. A good spawn iswhite in colour with profuse mycelia run and without any speck or blemish. Never the lessspawn production in itself is a promising venture of agri-preneurship.

Experimental Learning

Step 1: Preparation of Culture Media:

a. Preparation of potato dextrose agar (PDA)
b. 250 g potato is peeled and sliced in 1 lit. water and boiled for 30 minutes.
c. Potato extract is filtered through muslin cloth or net filter.

d. Potato extract, 20 g dextrose and 20 g agar and 200 mg Paraxin is mixed in a beakerbeaker and volume is made up to 1 litre with distilled water.
e. The 5 ml medium is poured into each cleaned test tubes and plugged with non- absorbent cotton.
f. Test tubes are sterilized in autoclave or pressure cooker at 15 psi pressure for 20 minutes.
g. Sterilized tubes are kept in a slanting position and allowed to solidify.



Step 2: Preparation of Nucleus Culture:

a. Well grown, disease free oyster mushroom is selected.
b. Sterilized PDA slants, razor blades, forceps etc. are kept inside the laminar flow chamber and the UV light is turned on for 20 minutes.
c. All the instruments is sterilized by exposing to Bunsen burner.
d. A small piece of tissue is cut from the centre of the split mushroom at the junction of pileus and stipe using a new sterilized blade.
e. The cotton plug of the agar slant is removed and the tissue is aseptically placed inside the slant by using a sterilized forceps and closed immediately.
f. After transferring tissues from the mushroom, the test tubes are kept inside BOD Incubator at 25OC (70% R.H.) for the growth of the fungus.

Step 3: Preparation of Mother Spawn:

a. Wheat grains is soaked into water, cleaned and chaffy and damaged grainswere removed.
b. The grains are cooked for 30 minutes to soften them.
c. Then the cooked grains and spread evenly on a plastic sheet.
d. 105 g Chalk powder ($CaCO_3$) (@5g/Kg) and 420 g Gypsum ($CaSO_4 \cdot 2H_2O$) (20g/kg)is mixed thoroughly with the cooked, dried grains.
e. Then the grains are filled in 8 X 6-inch polypropylene bags @200g/bag and necksare tied with cotton plug and rubber band.
f. The bags are sterilized inside an autoclave at 15 psi.
g. The bags are taken out and kept inside the laminar flow chamber and UV light is turned on for 20 minutes.
h. The nucleus culture is cut using a sterilized inoculation needle and the cut portion is transferred into the polypropylene bags.
i. The bags are sealed using cotton plugs and rubber bands.
j. The mother spawn bags are incubated in a clean room under room temperature for mycelial development.

Preparation of Mother

k. This can be used for commercial spawn preparation.

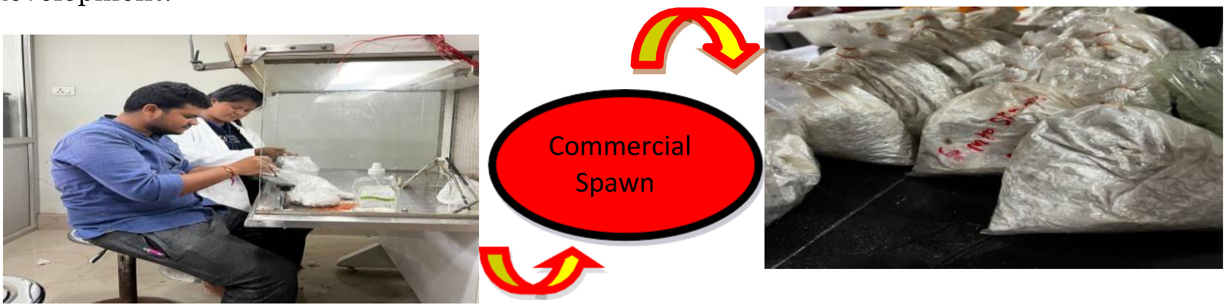
Step 4: Preparation of Commercial Spawn:

a. Sterilize treated-grain fill bags in autoclave or pressure cooker at 15 psi.

b. All the instruments are kept inside laminar flow chamber and UV light is turned onfor 20 minutes.

c. In laminar flow chamber 10 g mother spawn is transferred to treated-grain fill bags using a spatula and bags were sealed using cotton plugs and rubber bands.

d. Then, commercial spawn bags are incubated in a clean room under room temperature for mycelial development.



Expected Result

1. After 10- 12 days white mycelium growth should be visible in the PP bags.
2. From 1 bag (200g) of mother spawn 20 bags (200g each) of commercial spawn
3. Can be prepared.
4. Piece: Rs. 70 / 200g bag of commercial spawn.

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Novel Technologies for Improving Seed Germination

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Meshram Megha Rahul[1], Shendekar Siddhanath Ajinath[1], Raut Gopal Punjaji[1]
[1]Ph.D. Research Scholar, Department of Agricultural Botany, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra - 413722.

Introduction

Application of chemical and physical methods to improve seed germination may leads to structural damage, genetic dissimilarity in seeds to great extent and cause negative effects to life and nature. Emerging techniques mentioned below offer several other advantages over time honoured chemical and physical treatments.

Advantages

1. The amount of pesticides, fungicides are reduced, thus decreasing negative impact on the environment and living organisms.
2. The genetic deviation caused in seeds is very low.
3. These novel techniques can also be employed on seed even during storage, for disinfection prior to sowing.

Novel Technologies Tools

High pressure processing, Pulsed electric field processing, Ultrasound, Ozone processing, UV light, Magnetic field, Microwave radiation, Non thermal plasma, Electrolysed oxidising water and Plasma activated water.

1. High pressure processing (HPP): It is non-thermal food preservation technique that inactivates harmful pathogens and vegeta- tive spoilage microorganisms by using pressure rather than heat to effect pasteurization. Carried out at ambient temperature and at very high pressures of range 300–800 MPa for about 3–5 min, using a transmitting fluid (typically water). HPP in food application is governed by two relevant scientific laws.

Use in seed germination:

a. Elevating pressure level and exposure time which inhibited the metabolic and physiological process.
b. Beneficial for control of sprout.

2. Pulsed Electric Field Processing (PEF): Pulsed electric field (PEF) processing is an efficient non-thermal food processing technique using in short time at high voltage pulses. Changes the basic cell structure and breaks down the membrane of the cell (electroporation).

PEF application:

a. Pre-treatment step in preceding to dehydration
b. Extraction which improves the rate of mass transfer
c. Substitute for conventional disintegration method like grinding and maintenance of liquid media.

Advantages related to Seed Germination: Electric dipoles gets developed which line up themselves in the presence of electric field. As water is dipole, improving germination.

3. Ultrasound (US): The pressure waves of frequencies over the range 20 kHz known as ultrasound waves. The power ultrasound used in food treatment comprises sound waves of frequencies ranging from 20 to 100 kHz and sound intensity of 10–1000 W/cm2. The process of sonication, sound waves get conveyed as a series of rarefaction and compression cycles disturbing the molecules present within the liquid. The influence of ultrasound is attributed to the cavitation process which causes micro- streaming and enhances the transfer of heat and mass.

Impact on Seed Germination:

a. The mechanical effects produced by ultra-sonication created numerous small holes on the coating, fissures on pericarp which resulted in a notable rise in the moisture of seedlings.

b. The dominance of sonication may be because of the elevated holding capacity and high porosity, which increases the oxygen availability.

4. Ozone processing: Ozone (O3) is a molecule that exists in gaseous state and is produced from the oxygen molecule due to the combined effect of ultraviolet rays and electric discharges in the atmosphere. Half-life of about 12 h in the gaseous phase and 20–25 min in aqueous form (highly unstable). This instability causes the ozone gas to decompose violently at a very high temperature. Ozone being a powerful oxidizer has found a broad application in agriculture and food sector.
Impact on Seed Germination: Ozone breaches the dormancy in advance which is related to the reduced level of abscisic acid in ozone exposed seeds and on other side subjection to large period retarded the seed germination rate.

5. Ulta-Violet light (UV): Electromagnetic light radiation, UV light falls between the wavelength of range 100- 400 nm. It is further subcategorized into four bands- UV-A - 315 to 400 nm, UV-B - 280 to 315 nm, UV-C - 200 to 280 nm, vacuum UV - 100 to 200 nm
Use: UV-A and UV-C irradiation improves seed germination and growth while UV-B has harmful impact on cell membrane, DNA, disrupt Protein.

6. Magnetic field: The area around a magnet, where the force that is capable of magnetizing surrounding body exist is called a magnetic field. Seed germination was affected by two levels of field lines namely electromagnetic field exerted by the electrically charged object and static magnetic field. The positive effect of bio-stimulation with a static magnetic field depends on a minimum of two parameters: magnetic field intensity and exposure time.
Impact on Seed Germination: The seeds after exposure to magnetic field lines showed higher levels of α-amylase activity which improved germination.

7. Microwave radiation (MW radiation): MW radiation penetrates through a material, part of the energy is transmitted, part is reflected, and the remaining is absorbed by the material. The interaction of the electric field component of the microwave radiation with charged particles in the material produces a heating effect. This molecular movement is extremely fast at frequency 2.45 GHz where the dielectric heating is primarily by absorption of energy in water.
Impact on Seed Germination: The positive impact of microwave radiation on seed enhancement can be explained with the formation of hot spots and increased movement of water among seeds due to applied microwave frequency which enhances seed germination.

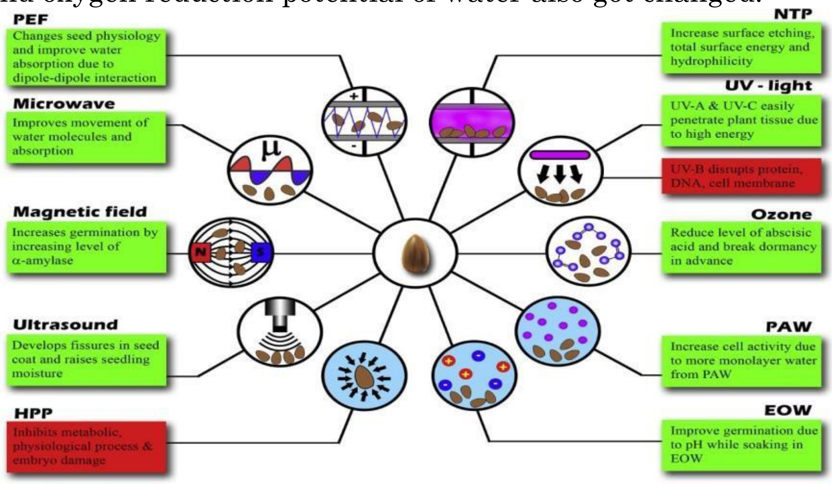
8. Non-thermal plasma (NTP): Plasma is a high energy state and comprises of negative and positive ions, electrons, neutral molecules, with the concentrations of each balanced making plasma as neutral overall. The types of plasma generated are thermal and non-thermal plasma (NTP) based on the mean temperatures of their heavy particles like ions and neutral species. In the thermal plasma, all the particles are in thermody- namic equilibrium, while a significant difference in kinetic energy caused by the temperature of elec- trons and the ambient gas particles is observed in non-thermal plasma.

9. Electrolyzed oxidizing water (EOW): Electrolyzed oxidizing water (EOW), also called as strongly acidic electrolyzed water (SAEW). To produce EOW electricity is passed through a solution of dilute salt water within which a membrane is placed to separate anode and cathode. The reaction at electrodes generates two products namely sodium hydroxide and hypochlorous acid.

The first kind is water formed from positive side (anode) called as EOW with pH (2.3– 2.7), ORP (Oxygen Reduction Potential) greater than 1000 mV and has dissolved oxygen and free chlorine. Water produced at cathode side known as electrolyzed reduced (ER) water has pH (10.0– 11.5), ORP of 800 to −900 mV.
Impact on Seed Germination:

a. SAEW-induced germination may arise from the depressed ABA (Abscisic acid) accumulation while raised GA (Gibberellic acid) accumulation. Moreover, SAEW reduced ABA content in seeds mainly by the promotion of ABA catabolism.
b. The reduced ROS accumulation may contribute to the improvement of germination induced by SAEW.

10. Plasma activated water (PAW): Plasma is fourth and high energy phase of matter has found a broad application in agriculture and food industry for nineteenth century. A new kind of water which is free of chemicals, salt and harmful processes called plasma activated water (PAW) were produced on exposing water to plasma. Water generated through plasma technology possessed to have a high value of pH and comprises of O radical, H radical, OH radical, reactive nitrogen and oxygen species. During the process, acidity, conductivity and oxygen reduction potential of water also got changed.



Use of PAW

1. PAW has found enormous applications in agriculture and food industry. The most vital application of water activated by plasma is microbial disinfection on food and processing equipment.
2. Treatment with PAW also eliminates bacteria and viruses on produce for a healthier food source.
3. PAW is utilized in the management of wastewater and the agricultural field, and is also shown to have a good impact on seed germination.

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Significance of Seed Halogenation Technique

Article ID: 40762

Meshram Megha Rahul[1], Shendekar Siddhanath Ajinath[1], Raut Gopal Punjaji[1]
[1]Ph.D. Research Scholar, Department of Agricultural Botany, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra - 413722.

Introduction

Seed is a biological entity and its ageing is an inevitable process beyond physiological maturity whether the seed is in mother plant or in storage. Rapid loss of vigour and viability of seed during storage is one of the major constraints faced by the seed industry and corresponding financial implication. Although ageing of seeds cannot be arrested completely when stored under ambient condition, it can however be controlled to an applicable extent by adoption of suitable storage technologies. Dry dressing of seeds with halogen formulation has conferred beneficial effect by lowering lipid peroxidation and there by extension of vigour and viability of seeds under storage. Halogen treatment slow down the deterioration senescence, reduce physiological and pathological deterioration in a number of crop seed.

Halogenation

1. Halogenation is a chemical process that occurs when hydrogen atoms are replaced by a halogen in an organic compound such approach is called halogenation.
2. Halogens consist of the element's fluorine, iodine, bromine and chlorine.
3. Halogenations to counter act and mitigate the free radical production, that accelerated the deterioration of seeds.

Objectives

1. Halogenation is an inexpensive and cost-effective storage technology.
2. Possible for both large and small-scale farmers.
3. Halogenation causing stability and render the extension of seed longevity.
4. It is found to be very effective in controlling the deterioration process.
5. The halogenation treatment for seeds having multifold benefits *viz,* increased germination %, vigour index, storability, the field performance etc.

Characteristics of Halogens

1. Halogens are present in group 17 or (VII) in the periodic table consisting of fluorine (F), chlorine (Cl), bromine (Br), and Iodine.
2. They gain electrons are very fast making them most reactive of all chemical elements.
3. They exist in all three classical states of matter - solid, liquid, and gas.
4. Halogen are diatomic when kept under room temperature.

Properties of Halogens

1. This is a typical property of non-metals. fluorine has the lowest melting point and boiling point.
2. State at room temperature. Room temperature is usually taken as being 25 c.
3. At this temp fluorine and chlorine are gases, bromine is liquid, and iodine and astatine are solids.
4. The halogen has low melting points and boiling points.

Materials Used as Inert Matter

The commonly available inert carriers are as follows:
Calcium carbonate fresh chalk, Talc, Charcoal or activated clay.

Halogens	Applied form
Chlorine	Bleaching powder
Iodine	Iodine crystals
Potassium iodide and bromine	Potassium bromide or bromine solution

1. In halogenations treatment, seeds are exposed to halogens like chlorine, bromine or iodine either directly or through the carriers.
2. These halogens are used for safe storage treatment with dual purpose that is utilization of seed for sowing and grain for consumption.

Purpose of Halogenation

1. It provides a protection mechanism to the seed preferably right in the beginning of storage, which will alleviate deteriorative seed senescence during storage.
2. This treatment could also extend their protection against the extrinsic factors of seed deterioration i.e., seed pathogen and insects.

Significance of Seed Halogenation

1. Avoids excess use of water.
2. It does not require drying back to safe moisture content for extended storage ability.
3. Ideal for large scale application and this treatment also has the additional cost-saving advantage that will occur if the dry treatment is given before the seed is bagged and stored.

Methodology for Incorporation of Halogens

The carrier is exposed to the halogen in vapour in optimum quantities.

↓

The vapour saturated carriers are dressed with the seeds.

↓

These chemicals are also added directly to the carrier.

↓

Among the carrier's calcium carbonate has been proved to be superior one.

↓

After equilibrating the carrier-chemical mix, the seed is thoroughly dressed with the mixture, in the closed container.

Anti-Microbial Properties of Halogens

1. It serves as a prime factor in extension of storability of seeds by the positive effect of halogen that reduces production of volatile aldehyde, which are presumably the product of lipid peroxidation.
2. In-turn reducing the growth of micro flora or pathogens those reduces the storability of the seeds.

Halogenation of the Seed

1. The halogens are obtained by adding 1ml of sulphuric acid to 50 mg of KCl or KBr or KI in a small Petri-dish placed in the bottom of a glass desiccator in which seeds are kept on the porcelain plate for required duration of exposure.
2. It is expressed that in vapors treatment the seeds are exposed to very low concentration of halogens like chlorine or iodine or bromine or alcohols, such as ethanol or iso- propanol for 16-72 hrs in a closed airtight container.
3. The concentration of chemicals and time of exposure would depend on the initial quality of seed used for treatment.
4. Chlorine may also be obtained by just placing bleaching powder and iodine by putting 25-50 mg of solid iodine crystals in the petri-dish.
5. In wheat, rice, pea, and egg plant seeds treatment with 2.3 g of bleaching powder per kg of seed effectively controlled the loss of vigour and viability of fresh seeds.

Methods for Application of Halogen Formulations to Seeds

1. The halogen formulation could be added to the seed similar to that of fungicide seed treatment and pesticide.
2. The chemicals are applied either dry dressing or slurry treatment using 5 ml of water per kg of seeds.
3. The efficacy of dry treatment is lower as compared to slurry treatment.

Factors Influencing Halogen Treatment

1. Selectivity of halogen for treatment
2. Duration of treatment
3. Dosage of halogen
4. Age of the seed
5. Selectivity of crop.

Advantages of Seed Halogenation

1. Maintenance of high germination of seeds during storage.
2. Protect seed from storage pest.
3. Significantly reduced storage fungi.
4. Early plant growth.
5. Increased root intensity.
6. Increased leaf area and chlorophyll cycle.

Disadvantages

1. Time consuming
2. Skilled manpower required.
3. Efficacy of halogen treatment is low as compared to other treatments *viz.* seed priming, seed pelleting, seed coating.
4. Halogenated Seeds in Storage
5. In storage halogenation of seeds with either iodine or chlorine prolonged the shelf life of seeds.

Conclusion

1. It can be concluded that seed dressing with halogen has the beneficial effect on lowering lipid peroxidation and free radical production, which are the basic cause of seed deterioration of the stored seeds and thereby extension of vigour and viability of seed under storage.
2. Halogenations of seeds increase the germination percentage of the stored seeds with increase in the vigour and viability and reduces the fungal and bacterial infection to the seeds.
3. The halogenation for maintaining seed quality parameters throws lights on the fact that iodine treatment with the seeds proved to be the best among all the halogens. It also shows that optimum dose on freshly harvested seeds of respective crop with decrease in duration indirectly increases the vigour and viability of the seeds.

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Agronomic Practices of Tuber Crops

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Himani B. Patel[1]
[1]Assistant Professor, Department of Vegetable Science, ASPEE College of Horticulture, Navsari Agricultural University, Navsari.

Introduction

Application of proper cultivation or agronomic practices have greater influence in yield and quality of tuber production. Agronomic practices vary with the crop, soil, climate, edaphic and topographic factors. Yield of any tuber crops can increase with good agricultural practices. Tuber crops includes sweet potato, greater yam, elephant foot yam and tannia.

Sweet Potato

B.N.: *Ipomoea batatas* L.
Family: Convolvulaceae
Soil: Well-drained, fertile, sandy loam, 5.2 to 6.7 pH
Climate: 20^0-27^0C temperature, 750 mm annual rainfall
Propagation: Vine cuttings or tubers
Time of planting: *Kharif:* June-August. Rabi: October-December.
Spacing: 60 cm x 20 cm
Seed rate: 83,333 vine cuttings/ha
Manures and Fertilizers: 10 t/ha FYM; 75:50:75 NPK kg/ha
Irrigation: 10-15 days interval
Weeding and Earthing up: 30 and 50 days after planting
Harvesting: 100-135 days after planting
Yield: 10-20 t/ha.

Greater Yam

B.N.: *Dioscorea alata* L.
Family: Dioscoreaceae
Soil: Well-drained, loose friable, sandy loam, 5 to 7 pH
Climate: Warm, 25^0-30^0C temperature
Propagation: 250 g tuber
Time of planting: March- May
Spacing: 90 cm x 90 cm
Manures and Fertilizers: 20 t/ha FYM ; 80:60:80 NPK kg/ha
Irrigation: Weekly interval

Weeding and Earthing up: 30 and 60 days after planting & then as per requirement
Staking: Within one month of planting to increase tuber production
Harvesting: 9 months after planting
Yield: 30-40 t/ha.

Elephant Foot Yam

B.N.: *Amorphophallus paeoniifolius* (Dennst.) Nicolson.
Family: Araceae
Soil: Well-drained, well-aerated, 30^0-35^0C temperature, 1000-1500 mm annual rainfall
Propagation: 500-750 g corm pieces
Spacing: 90 cm x 90 cm or 60 cm x 60 cm
Manures and Fertilizers: 25 t/ha FYM ; 80:60:100 NPK kg/ha
Irrigation: Subsequent irrigation should be given on the requirement of plant
Weeding and Earthing up: 2-3 weeding and earthing up requires
Harvesting: 6-7 months after planting
Yield: 60-70 t/ha.

Tannia

B.N.: *Xanthosoma sagittifolium* (L.) Schott.
Family: Araceae
Soil: Well-drained, sandy loam to clay & fertile, 5.5 to 7 pH
Climate: Hot and humid condition, 25^0- 30^0C temperature, 1500-2000 mm annual rainfall
Propagation: 50-80 g corm or small cormel
Time of planting: April-May
Spacing: 90 cm x 90 cm
Seed rate: 600-1000 kg cormel or 1800-2500 kg mother corm
Manures and Fertilizers: 20 t/ha FYM ; 80:60:80 NPK kg/ha
Irrigation: Subsequent irrigation should be given on the requirement of plant

Weeding and Earthing up: 2-3 weeding and earthing up requires
Harvesting: 9 months after planting
Yield: 20-30 t/ha corms or 3 t/ha leaves yield.

Conclusion

Agronomic practices of tuber crops include soil management, cultivation, spacing, irrigation, weeding, *etc*. Different tuber crops have different cultivation practices which depends on different environmental condition. It provides favourable environments to the crop for higher yield and productivity in tuber crops.

Bio -Fertilizers for Soil Health Management: Boon for Organic Agriculture

Article ID: 40764

Kiranbeer Kaur[1]

[1]Student masters in food science and technology, Department of Food science and technology I. K. Gujral Punjab Technical University, Kapurthala (Punjab).

Abstract

As agricultural land becomes scarcer over time and even drastically shrinks, the annual increase in human population poses a serious threat to people's ability to feed themselves. To meet the enormous demand for food from the growing population, agricultural productivity must be significantly increased over the next few decades. Not to mention that relying too heavily on chemical fertilizers will severely harm both the ecosystem and human health to increase crop production. One of the greatest natural gifts of agricultural science is the development of bio-fertilizers as an alternative to chemical fertilizers. The microorganisms in bio-fertilizer encourage the proper supply of nutrients to the host plants and ensure that their growth, development, and physiology are properly regulated. Bio-fertilizers, which have specific properties to promote plant growth and reproduction, are made using living microorganisms. As significant elements of sustainable farming, bio-fertilizers have an important function in preserving long-term soil fertility and the sustainability of crop production.

Keywords: Bio-fertilizer, Organic Farming, Sustainable Agriculture, Microorganisms.

Introduction

Natural farming plays an important role for the safe and healthy production of food because of no use of Agrochemicals. The chemical fertilizers deplete the soil quality which leads to environmental pollution and create Health Hazard for Human. So, there is an urgent need to adopt organic food production to grow safe and healthy food (Mishra et.al, 2012,). Organically grown food is food grown and processed using no synthetics and chemicals. Living fertilizers take part in a significant part in natural farming these are substances containing living cells with the capability of nitrogen fixation, and phosphate solubilizing and help in maintaining soil fertility and enhancing production and productivity. These applied microbes multiply themselves and make the nutrient available for the soil and fix atmospheric nitrogen and improve soil fertility it helps in mixing non-soluble soil phosphorus and promotes development factors for soil. The function and role of Bio-fertilizers in organic production studied by many authors but it does not get much response due to a lack of awareness from the study only 30 %of India's area is cultivated land rest is arable land and rain-fed and rarely chemicals are used and adopting organic manuring and farming from the study we get to know north India is best for organic farming and has a tremendous ability to supply organic product and organic farming capability (Venkatashwarlu, 2008). As we know that by chemical fertilizers led to exploit soil nutrient and soil fertility so India can grow crops organically so Bio-fertilizers plays an important role in organic farming to save the soil fertility and make nutrient available to plants without harming the soil status and Health and led to sustainable agriculture and production for future generations (S. Sheraz Mahdi, G. I. Hassan, S. A. Samoon, H. A. Rather, Showkat A. Dar, and B. Zehra).

Why there is a Need for Biofertilizers in Organic Agriculture?

With the use of synthetic chemical fertilizers and sprays soil get polluted and nutrients get exploited as also polluted the irrigated water that is used for irrigation. Bio-fertilizers play an important role to promote sustainability. These live and latent cells help to promote plant production organically without depleting the soil. These Bio-fertilizers reduce health and soil hazard, due to excessive use of chemical fertilizers soil gets depleted water get polluted available nitrogen content decrease so there is a great need to adopt methods like sustainable farming to save the soil and soil fertility and make the nutrients in available form. (Venkataraman and Shanmugasundaram, 1992). Required Demand is higher than total production. It is studied that in 2021, get the production of 321 million tons of any kind of food, the required amount for nutrients will be 28 million tons and their availability is only 20 million tons to 7.2 million tons. (Mishra D.J., Rajvir, U.K. and ShahiSudhir Kumar) and the main reason is that the price of these synthetic fertilizers is very high and prices are not affordable for marginal farmers so there is a great need to adopt such methods for low-cost production and productivity and eco-friendly farming to conserve our soil and soil parameters.

Some Bio-Fertilizers Used for Organic Farming

1. Rhizobium: It belongs to the family Rhizobiumceae and it is symbiotic and helps in fixing nitrogen it is mainly useful for pulse legumes and fodder crops. It forms galls like structure on the root nodule that structure help to fix atmospheric nitrogen and make plants nutrients available and non-legumes also can fix nitrogen and growth is only enhanced when there is sufficient formation in Rhizobium in plants (Kumar et al 2013, popular Kheti) Rhizobia fix the nitrogen symbiotically and population of Rhizobium depend on the population of legumes in the fields or artificial inoculation can be done to increase the population of Rhizobium. Rhizobium is the major and most important Bio-fertilizers among all and helps to fix nitrogen in great amounts and make the nitrogen available in the soil. Each legume requires a species of rhizobium for nodulation.

2. Azospirillum: It belongs to the family Spirilaceae and its mode of nutrition is Hetero-trophic and provides nitrogen 21- 46 kg per hectare. These show symbiosis and also show associative symbiosis with those plants that are following the C4 photosynthesis pathway because it forms organic salts and fixes nitrogen automatically and they did not remain in the soil but penetrate deep down in both plant and soil. Plant tissues make the nutrient available and fix the atmospheric nitrogen. Azospirilium is highly required for maize, sugarcane, Bajra; etc. and they did not form anything like root nodules but they fix the nitrogen in high amounts and are highly accepted for organic farming. (Mishra D.J., Rajvir, U.K. and ShahiSudhir Kumar).

3. Azotobacter: Azotobacterbelongs to the family Azotobacteraceae. They are free living and Holo-trophic modes of nutrition found in Azotobacter. They are sometimes naturally present in alkaline and neutral soils Chroococcumous are considered as best of all Bio-fertilizers. They synthesize some biological development enhancements like Vitamin B, IAA, and Gibberellin. The organism is found in the rhizosphere in many crops' plants from Rabi and Kharif crops, (Arun, 2007). These also show legume symbiosis with some plants and help to fix nitrogen and promote plant growth and improve yield per hectare (Doroshenko and Rawia, 2007. Rawia et al 2009).

3. Azolla: It is better known as Nitrogen fertilizers they float on the surface of the water and then fix the nitrogen and they are symbiotic they are mostly found in water bodies and temperate regions Azolla provide carbon to the Anabela and then fix the atmospheric nitrogen and this is mostly found in rice and wet bodies and then act as manure to the soil and help to inculcate nutrients in the soil (Galal,1997) Azolla provide both N and K to both plants and humans and they increase the yield of rice and other crops that are mainly required water in the large amount they also act as mosquitoes repellent (Singh,1977).

Role of Bio-Fertilizers in Agriculture

The purpose of biofertilizers is to improve agriculture's efficiency and sustainability. These goods are made of organic material, which supports the idea that avoiding synthetic and chemical additives will improve farming methods. Bio-fertilizers use materials and microorganisms that encourage the soil's natural processes. Plant development and growth are impacted by these processes. Therefore, biofertilizers enhance biological processes through microorganisms, which in turn indirectly improve plant growth. By adding extra nutrients to the soil or plant, fertilizers, in contrast, directly aid in the growth of crops. In the meantime, biofertilizers make use of the earth's pre-existing microbes to enhance a plant's nutrient uptake.

Conclusion

Bio-fertilizers play a great role in the fixing of atmospheric nitrogen and low-cost production with high yield they help in enhancing soil fertility for more time and help in maintaining atmospheric nitrogen and fixing all required nutrients and transferring them into Phosphorus form to the plants via soil. So, we have to take steps toward promoting organic farming by using these living manures to maintain soil fertility and enhance productivity. So, there is a high need to adopt this method to generate sustainability and sustainable agriculture to save the soil and earth for future too for upcoming generations.

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Molecular Farming

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Dr. Varsha Kumari[1]

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

Introduction

It is defined as the use of genetically modified organism (GMOs) for production of proteins, other metabolites, renewable raw materials, fine chemicals and dietary supplements that are extremely important as medicine or to industry. It aims to provide pharmaceutical drugs, like vaccines and therapeutic proteins for treating cancer, heart, liver and kidney disease more abundantly and inexpensively. It is new source of molecular drugs, as plasma proteins, hormones, growth factors, vaccines and recombinant antibodies whose medical uses are known at the molecular level (Jian *et al*., 2015).

Why Molecular Farming?

1. Plants can synthesize a wide variety of proteins that are free of mammalian toxins and pathogens
2. Plants can produce large amounts of biomass at low cost and require minimum facilities
3. Plants have long been used as a source of medicinal compounds
4. Plant as bioreactors are easy to store
5. Plant products are much safer than animals and microbes
6. Easy to purify plant-based proteins.

Requirement

The technique used in this approach is genetic modulation of plants to produce specific compounds *viz*., proteins which needs post-transcriptional modification for activation. After harvesting these products then extracted and purified for application. This technique requires an agricultural setting after the desired protein gene is inserted in plants.

Procedure

Generally, genetic transformation is carried out using *Agrobacterium tumefaciens*. The protein of interest is often expressed under the control of the cauliflower mosaic virus 35S promoter (CaMV35S), a powerful constitutive promoter for driving expression in plants. Signal localization peptide sequence is attached to the recombinant protein to express in a specific sub-cellular location, such as chloroplasts or vacuoles, in order to improve yields, make simpler purification process, or so that the protein folds properly. Primarily, Arabidopsis use to study gene expression in plants, but in case of actual and mass production maize, wheat, rice, potatoes, tobacco, flax or safflower are used. Among them, tobacco is the popular organism for the expression of transgenes, as it is easily transformed, produces abundant tissues, and persists well in vitro as well as in greenhouses. On the other hand, the advantage of rice and flax is that they are self-pollinating, and thus gene flow issues are avoided. Besides, human error could still result in pharm crops entering the food supply is a potential risk factor. However, it can be minimized by expressing the recombinant proteins in plants vegetative or producing sterile hybrids, but at a high cost. Another way of reducing the threat is using a minor crop like safflower or tobacco.

Steps of Molecular Farming

1. Selection of gene of interest
2. Cloning
3. Transformation
4. Bacterial culture
5. Expression
6. Extraction
7. Purification.

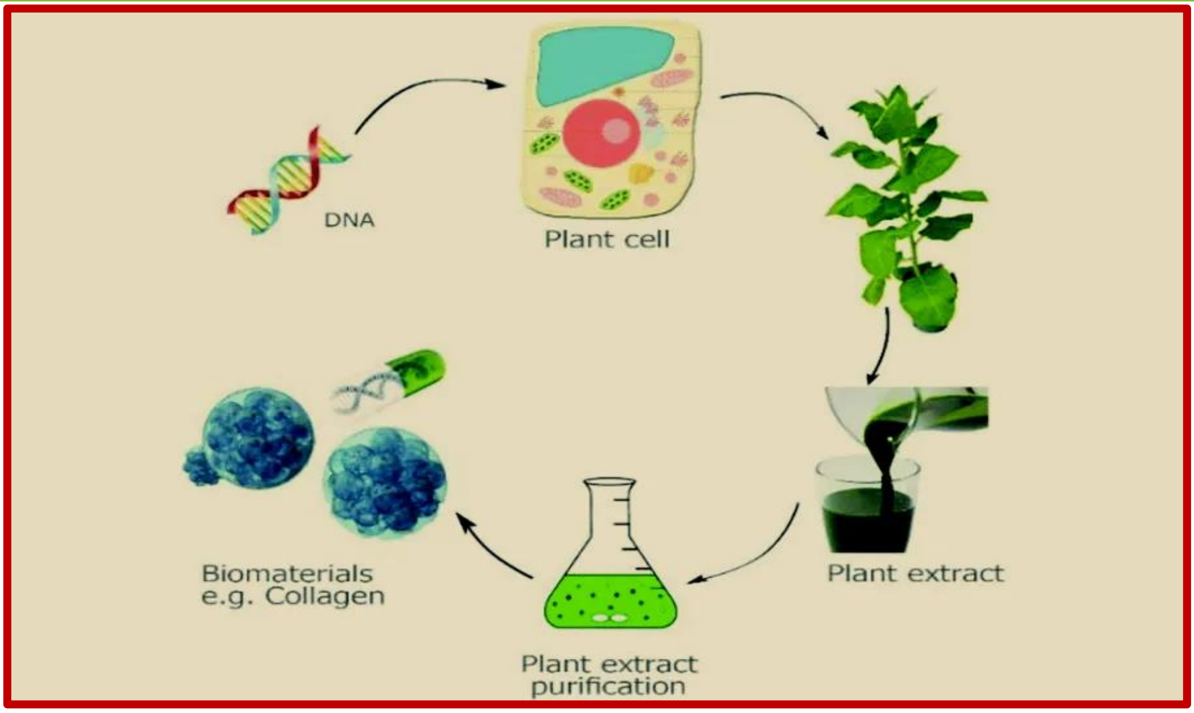

Figure: Steps of molecular farming

Molecular farming involves several distinct strategies for gene transfer that may involve either stable transformation or transient expression. Alternatively, cell lines can be derived from transgenic plants directly. It is also possible to introduce transgenes into the plastid genome of certain species to generate transplastomic plants (Khaled *et al*., 2015). Molecular pharming provides an opportunity for the economical and large-scale production of pharmaceuticals, industrial enzymes and technical proteins that are currently produced at great expense and in small quantities. Molecular farming may not run away from the safety issues of genetically modified plants. Recent developments in omics technologies and precise genome editing tools such as CRISPR may accelerate the adoption of plant based biological manufacturing to turn GM plants into green factories. Ultimately we must ensure that these benefits are not outweighed by risks to human health and the environment (Mark *et al*., 2016).

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Plant Genetic Resource Conservation in Gene Bank

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Nivethitha. M[1]
[1]Ph.D Scholar, Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu - 641 003.

Introduction

The sum total of hereditary material i.e. all the alleles of various genes, present in a crop species and its wild relatives is referred to as germplasm. This is also known as genetic resources or gene pool or genetic stock. Important features of plant genetic resources are given below. Genetic pool represents the entire genetic variability or diversity available in a crop species. Germplasm consists of land races, modern cultivars, obsolete cultivars, breeding stocks, wild forms and wild species of cultivated crops. Germplasm includes both cultivated and wild species and relatives of crop plants. Germplasm is collected from centres of diversity, gene banks, gene sanctuaries, farmer's fields, markers and seed companies. Germplams is the basic material for launching a crop improvement programme. Germplasm may be indigenous (collected within country) or exotic (collected from foreign countries).

Germplasm Conservation

Conservation refers to protection of genetic diversity of crop plants from genetic erosion. There are two important methods of germpalsm conservation or preservation. i) In-situ conservation and ex situ conservation. These are described below.

1. In - situ conservation: Conservation of germplasm under natural conditions is referred to as in situ conservation. This is achieved by protecting the area from – human interference, such an area is often called natural park, biosphere reserve or gene sanctuary. NBPGR, New Delhi, established gene sanctuaries in Meghalaya for citrus, north Eastern regions for musa, citrus, oryza and *saccharum*. Gene sanctuaries offer the following advantage.

Merits: In this method of conservation, the wild species and the compete natural or seminatural ecosystems are preserved together.

Demerits:

a. Each protected area will cover only very small portion of total diversity of a crop species, hence several areas will have to be conserved for a single species.
b. The management of such areas also poses several problems.
c. This is a costly method of germplasm conservation.

2. Ex - situ conservation: It refers to preservation of germplasm in gene banks. This is the most practical method of germplasm conservation. This method has following advantages.

a. It is possible to preserve entire genetic diversity of a crop species at one place.
b. Handling of germplasm is also easy.
c. This is a cheap method of germplams conservation.
d. This type of conservation can be achieved in the following 5 ways.

Seed Banks

Germplam is stored as seeds of various genotypes. Seed conservation is quite easy, relatively safe and needs minimum space. Seeds are classified, on the basis of their storability into two major groups.

1. Orthodox.
2. Recalcitrant.

Orthodox seeds: Seeds which can be dried to low moisture content and stored at low temperature without losing their viability for long periods of time is known as orthodox seeds. (eg.) Seeds of corn, wheat, rice, carrot, papaya, pepper, chickpea, cotton, sunflower.

Recalcitrant: Seeds which show very drastic loss in viability with a decrease in moisture content below 12 to 13% are known as recalcitrant seeds. (e.g) citrus, cocoa, coffee, rubber, oilpalm, mango, jack fruit etc.

Seed storage: Based on duration of storage, seed bank collects are classified into three groups. (1) Base collections. (2) Active collections and (3) Working collection.

Base collections: Seeds can be conserved under long term (50 to 100 years), at about -20OC with 5% moisture content. They are disturbed only for regeneration.

Active collection: Seeds are stored at 0OC temperature and the seed moisture is between 5 and 8%. The storage is for medium duration, i.e., 10-15 years. These collections are used for evaluation, multiplication, and distribution of the accessions.

Working collections: Seeds are stored for 3-5 years at 5-10OC and the usually contain about 10% moisture. Such materials are regularly used in crop improvement programmes.

Plant Bank

(Field or plant bank) is an orchard or a field in which accessions of fruit trees or vegetatively propagated crops are grown and maintained.

Limitations:

a. Require large areas
b. Expensive to establish and maintain
c. Prone to damage from disease and insect attacks
d. Man – made
e. Natural disasters
f. Human errors in handling.

Shoot Tip Banks

Germplasm is conserved as slow growth cultures of shoot-tips and node segments. Conservation of genetic stocks by meristem cultures has several advantages as given below.

Each genotype can be conserved indefinitely free from virus or other pathogens. It is advantageous for vegetatively propagated crops like potato, sweet potato, cassava etc., because seed production in these crops is poor. Vegetatively propagated material can be saved from natural disasters or pathogen attack. Long regeneration cycle can be envisaged from meristem cultures. Regeneration of meristerms is extremely easy. Plant species having recalcitrant seeds can be easily conserved by meristem cultures.

Cell and organ banks: A germplasm collection based on cryopreserved (at – 196OC in liquid nitrogen) embryogenic cell cultures, somatic/ zygotic embryos they be called cell and organ bank.

DNA banks: In these banks, DNA segments from the genomes of germplasm accessions are maintained and conserved.

Germplam Evaluation

Evaluation refers to screening of gemplasms in respect of morphological, genetical, economic, biochemical, physiological, pathological and entomological attributes. Evaluation of germplasm is essential from following angles. To identify gene sources for resistance to biotic and abiotic stresses, earliness, dwarfness, productivity and quality characters. To classify the germplasm into various groups. To get a clear picture about the significance of individual germplasm line. IPGRI, Rome has developed model list of descriptors (= characters) for which germplasm accessions of various crops should be evaluated. The evaluation of germplasm is done in three different places viz., (1) in the field (2) in green house a) 3) in the laboratory.

Germplasm Cataloguing, Data Storage and Retrieval

Each germplasm accession is given an accession number. This number is pre fixed in India, with either IC (Indigenous collection), EC (exotic collection) or IW (Indigenous wild). Information on the species and variety names, place of origin, adaptation and on its various feature or descriptors is also recorded in the germplasm maintenance records.

Catalogues of the germplasm collection for various crops are published by the gene banks. The amount of data recorded during evaluation is huge. Its compilation, storage and retrieval are now done using special computer programmes.

National Bureau of Plant Genetic Resources (NBPGR)

NBPGR establishment in 1976 is the nodal organisation in India for planning, conducting, promoting, coordinating and lending all activities concerning plant. Collection, Introduction, Exchange, Evaluation, Documentation, Safe conservation, Sustainable management of germplasm.

Vegetable Crop Responsibilities and Germplasm Activities at NBPGR

The vegetable crop germplasm programme broadly includes the following vegetable crops for evaluation, documentation and maintenance of active collections besides their long term storage.

A.	Solanaaceous	:	Brinjal, tomato, chillies
B.	Cucurbitaceous Vegetables	:	Pumpkin, melons, gourds and cucumber
C.	Leguminous vegetables	:	Cowpean, pea, lablab bean, winged bean, faba bean, French bean
D.	Bulb crops	:	Garlic, onion
E.	Root vegetables	:	Radish, carrot, turnip
F.	Okra	:	-
G.	Miscellaneous vegetables	:	Cole crops, Chinese cabbage, spinach beet, spinach

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Grafting in Solanaceous Crops

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Ms. Nagma R. Surve[1]
[1]Ph. D. Student, College of Horticulture, Dapoli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli.

India is the second largest producer of vegetables in the world. It produces 188284 thousand MT of vegetables from an area of 10310 thousand hectares (Anon., 2021). Among the various families of vegetable crops, Solanaceae is the foremost family including economically important crops like tomato, chilli, capsicum, brinjal and potato.

Need of Grafting

Solanaceous crops are popularly cultivated in the rice-based cropping system in Konkan region of Maharashtra during *rabi* season. However, commercial cultivation of these vegetable crops poses several restrictions and one of the most important is the incidence of bacterial wilt disease. The healthylooking plants of these crops suddenly collapse due to the incidence of bacterial wilt disease. The infection of bacterial wilt may be up to 100 % per cent in the field depending upon the susceptibility of the variety. The F_1 hybrids of various solanaceous are popular for cultivation due to their high yield and quality. However, many of these hybrids are proved to be susceptible to bacterial wilt in Konkan region. Therefore, bacterial wilt in solanaceous crops caused by *Ralstonia solanacearum* strain 1 is the major limitation for the commercial scale cultivation of these vegetable crops in Konkan region. Though, several varieties of crops like brinjal *viz*. 'Arka Neelkanth', 'Swarna Pratibha', 'Konkan Prabha'; tomato *viz*. 'Konkan Vijay', 'Sonali', 'Arka Abha' etc have been recommended as resistant to bacterial wilt with better field adaptation but the size, shape, colour and the quality of these varieties is not much accepted in the local markets of production belts. Thus, it is very vital to find out the technology which will help to impart the solution of this particular biotic stress in the vegetable cultivation so that the location specific popular and consumer preferred varieties and commercial hybrids can be grown in agro-climatic conditions of Konkan region especially during *rabi*-summer season.

What is Grafting in Vegetable Crops?

Grafting is a feasible solution to solve the issues related to several biotic and abiotic stresses in vegetable cultivation. Grafting is a natural or deliberate fusion of plant parts where the vascular continuity is established between the plant parts resulting in a composite organism functioning as a single plant. (Yassin and Hussen, 2015). Vegetable production with grafted seedlings was originated in Japan and Korea to avoid the serious crop loss caused by infection of soil-borne diseases aggravated by successive cropping (Lee *et al*., 2010). This practice is now rapidly adapted and expanding over the world. Grafting of vegetable crops is used to provide resistance to soil pests and pathogens, to increase the tolerance to abiotic stresses like salinity, drought, waterlogging etc., to improve water or nutrient uptake as well as to enhance the vigour of the scion. This approach is eco-friendly for the sustainable vegetable cultivation and also by using the resistant rootstocks, the dependence on agrochemicals can be reduced. Hence, grafting of vegetables on suitable rootstock with desirable scion variety/hybrid is commercially adopted technique in various countries for overcoming the problem of various biotic stresses like bacterial wilt in solanaceous vegetables and fusarium wilt in cucurbits.

Vegetable Grafting History

The initial effort in vegetable grafting was done by grafting watermelon scion (*Citrullus lanatus*) on pumpkin rootstock (*Cucurbita moschata*) in Japan and Korea in the late 1920s. Also, self-grafting technique was also used to produce large-sized gourds fruits described in a Chinese book in the 5th century and Korean book written in the 17th century. However, the commercial grafting of vegetable crops was commenced in the early 20th century with the aim of controlling soil borne pathogens. Among the solanaceous crops, aubergine (*Solanum melongena* L.) was first grafted on scarlet aubergine (*Solanum integrifolium* Lam.) in the 1950s. Likewise, grafting in tomato (*Solanum lycopersicum* L.) was started in the year 1960 (Lee and Oda, 2003). By 1990, the percentage of grafted Solanaceae and Cucurbitaceae vegetables had increased to 59% in Japan and 81% in Korea (Lee, 1994).

Vegetable Grafting in India

In India, grafting work was started in IIHR, Bangalore by Dr. R. M. Bhatt and his associates to select best rootstocks for water-logging conditions. The *Momordica cochinchinensis*, a dioecious vegetable crop was grafted on male vines of same crop as a rootstock and female plant as scion in the NBPGR regional station, Trissur, Kerala. CSKHPKV, Palampur initiated work on grafting in solanaceous crops mainly against bacterial wilt and identified more than 22 rootstocks of brinjal, chilli, tomato and cucurbits for imparting resistance to bacterial wilt and nematodes (Kumar *et al*., 2018). Private companies like "VNR Seed Private Limited" (www.vnrnursery.in) and "Takii Seed India Private Limited" (www.takii.com/vegetables) are also involved in vegetable grafting and supplying quality grafts. Recently ICAR-IIVR, Varanasi, Uttar Pradesh emerged with the dual grafting of brinjal and tomato (brimato) where the Brinjal Hybrid – 'Kashi Sandesh' and improved cultivar of Tomato – 'Kashi Aman' were successfully grafted into brinjal rootstock – 'IC 111056'(www.icar.org.in).

Methods of Vegetable Grafting

Vegetable grafting methods vary greatly depending upon the kind of vegetable crops, experiences of farmers, facilities and the machines available. The splice, cleft and tongue method of grafting have been found suitable and their success varies according to crops.

Procedure of Vegetable Grafting in Solanaceous Crops

The rootstocks resistant to the bacterial wilt and the scion variety (fruits preferred by local markets) are selected. Accordingly, the rootstock and scion seedlings are grown in the protrays. The rootstock seedlings should be sown one week earlier than that of scion ones to match the stem girth at the time if grafting. After attaining proper stage, grafting is done by splice grafting (mostly used method). The silicon grafting clips varying from size of 1.5 mm to 1.9 mm are used to hold the graft union till its union.

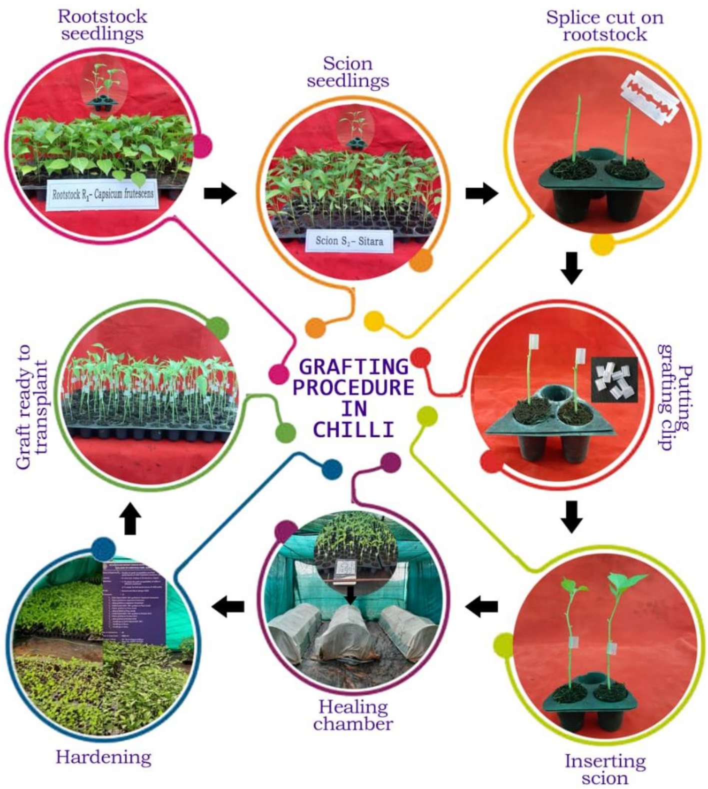

Plate 1. Vegetable grafting procedure

Grafting should be performed under shade (upto 90 percent) during cool hours preferably in early morning and late evening. The prepared grafts should be immediately placed in the healing chamber having relative humidity 90-95% to maintain turgidity which is necessary for high grafting success. After five to six days of grafting, the humidity should be decreased gradually with increasing the light. After healing of graft union for about 1 week, grafts should be then transferred in the shade net conditions for hardening where they should be gradually exposed to the open conditions for complete hardening up to 21 days before transplanting. The sprouts on rootstock growths below the graft union should be removed periodically. Theses grafts are now ready for transplanting in the fields. The pictorial representation of grafting procedure is depicted in Plate 1.

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Trapping of Fall Armyworms in Vegetable Nursery

Article ID: 40768

Ms. Nagma R. Surve[1]

[1]Ph. D. Student, College of Horticulture, Dapoli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli.

Fall armyworm is the most destructive pest in the solanaceous vegetable crops. This pest attacks the crop from the beginning of the growth stage *i.e.*, at the nursery stage and knocks down the crop on the large scale. Though this pest can be controlled by various pesticides, controlling them at an early stage of crop by the help of cultural means can be very useful for farmers.

Fall armyworm is one of the most prominent pests of the Spodoptera species falling in the order of Lepidoptera. The larval stage of this pest gathers in huge masses *i.e.*, armies and hence it is called as 'armyworm'. They destroy the large tracks of crops at once. They are nocturnal in nature and most active during warm and humid evenings. The larval stage of this pest is the most destructive stage. They feed on the leaves of seedlings as well as cut the seedlings at the collar region which collapses the seedlings and therefore also called as cutworms.

During the growing of seedlings of solanaceous vegetables in the shade net house, fall armyworm infestation was observed right from the emergence of seedlings. Young larvae initially consumed the leaf tissues, further by the second or third instar larvae made the holes in the leaves causing the excessive defoliation of the seedlings. This adversely affected the growth and vigour of the seedlings causing an irreversible destruction. Due to their nocturnal habitat, the larvae cannot be observed during day times as they tend to hide during day and feed during nights.

Fall armyworm larvae consume the foliage and young leaves of various plants like various grasses, sweet corn, cotton, etc. This feeding habit of the larvae was successfully used to prepare the false trap for the pest control in the early stage of crop growth.

In the shade net house, during the day time, larvae used to hide below the portrays, weed mat, pots, etc. and attack the crop during the night. Due to their habit of hiding below the places at night and feeding on the young foliage of the crop, false traps of the young grass heaps should be arranged in the periphery of the protrays containing the seedlings. This trap will lead the larvae to feed on the young foliage of the grass during night and hide below it during day times. Next day the grass heaps are rolled downwards to observe the larvae and then larvae hiding below it can be destroyed together. The continuous process of using such grass heaps false traps for one week will help to greatly reduce the population of the fall armyworm. Hence, without the use of pesticides at early crop stage, the fall armyworm can be controlled effectively.

Plate 1. Damage of seedlings caused due to the attack of fall armyworm

Plate 2. False trap of grass heaps

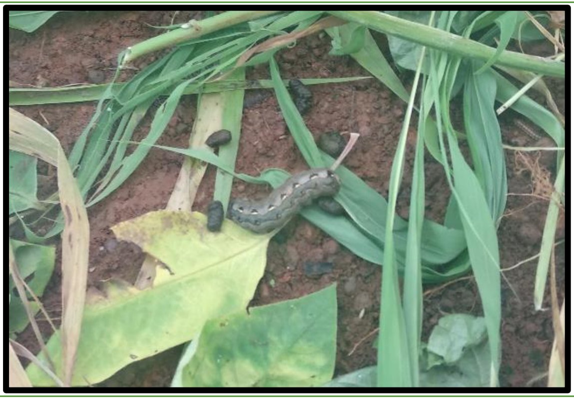

Plate 3. Fall armyworm found below false trap of grass heaps

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Impact of Microplastic Pollution on Soil Health

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Prabhakar Prasad Barnwal[1], Rosin K.G.[2], Abhishek Jangir[1], Surya Prakash Yadav[1], Kajal Singh[3], Sarvendra Kumar[1]

[1]Division of Soil Science and Agricultural Chemistry, ICAR-Indian Agricultural Research Institute, New Delhi-110012.

[2]Water Technology Centre, ICAR-Indian Agricultural Research Institute, New Delhi-110012.

[3]Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh-221005.

Introduction

Plastic is one of the most widely used materials in the world. Its durability and versatility have made it a popular choice for a wide range of applications, from food packaging to household items to electronic devices. With the immense pace of increasing population growth, the production of global plastics has also increased tremendously, which is almost doubled in last two decades producing 460 million tonnes (Mt) in 2019. It is also estimated that if capping is not done in manufacturing, plastic production is projected to be tripled from its 2019 levels, *i.e.* 1231 Mt by 2060 (OECD, 2022).

The present scenario of demographic data, plastic production, low recovery rate, and use/disposal patterns; all points to increasing accumulation of plastic waste in our oceans, posing a significant threat to marine life, and now plastic pollution has also become a significant concern in soil ecosystems. Plastics are persistent and even though these are recyclable, only 9% are reclaimed (Fig. 1) while major portion stay in environment which are subjected to fragmentation through various biotic and abiotic agents producing small fragments and particles known as microplastics. Microplastics are small plastic particles that are less than five millimeters in size.

They are widely used in products such as cosmetics, cleaning agents, and textiles. Microplastic pollution in soil is a growing environmental concern that is receiving increasing attention from researchers and policymakers. Microplastics can enter soil ecosystems through various pathways, including the direct disposal of plastic waste, the use of plastic mulch in agriculture, and the application of sewage sludge to soil.

The impact of microplastic pollution in soil is not yet fully understood, but there is growing evidence to suggest that it can have adverse effects on soil health and the wider ecosystem. This article will explore the impact of microplastic pollution in soil in more detail, examining the pathways of microplastic pollution in soil, the potential risks associated with microplastics, and the measures that can be taken to mitigate the impact of microplastic pollution in soil.

Pathways of Microplastic Pollution in Soil

Microplastic pollution can enter soil ecosystems through various pathways, including the direct disposal of plastic waste, the use of plastic mulch in agriculture, and the application of sewage sludge to soil. The direct disposal of plastic waste is one of the most significant contributors to microplastic pollution in soil. Plastic waste can be deposited in landfill sites, where it can degrade into smaller plastic particles that can then be carried into soil ecosystems through rainfall and wind. Plastic waste can also be littered in the environment, where it can accumulate in soil. The use of plastic mulch in agriculture is another pathway for microplastic pollution in soil. Plastic mulch is commonly used in agriculture to control weeds, conserve soil moisture, and regulate soil temperature. However, plastic mulch can degrade over time, releasing microplastics into the soil. The application of sewage sludge to soil is another pathway for microplastic pollution in soil. Sewage sludge is the semi-solid material that remains after wastewater treatment. Sewage sludge can contain microplastics that have been flushed down the drain, such as microbeads from cosmetics and microfibers from textiles. When sewage sludge is applied to soil, these microplastics can be released into the soil ecosystem.

Impact of Microplastics on Soil Physical Health

Microplastic pollution is a growing concern for the environment and human health. While most research has focused on the effects of microplastics on aquatic ecosystems, recent studies have shown that microplastics can also impact soil health, including soil physical properties. The effects of microplastic pollution on soil physical health include changes in soil structure, soil water-holding capacity, and soil aeration, among others.

One of the most significant impacts of microplastic pollution on soil physical health is the alteration of soil structure. Microplastics can change soil structure by physically altering soil aggregates, which are important for soil porosity and water infiltration (Qiu *et al.*, 2022). This can lead to soil compaction, reducing soil aeration and water-holding capacity, which can negatively impact plant growth and productivity.

Furthermore, microplastics can also impact soil water-holding capacity. Studies have shown that microplastics can decrease soil water-holding capacity by physically blocking water movement and clogging soil pores (Wang et al., 2023). This can lead to reduced plant growth and increased runoff, which can result in soil erosion and water pollution. Additionally, microplastics can also impact soil aeration. Soil aeration is critical for soil microbial activity, as many soil microorganisms require oxygen for respiration. Microplastics can decrease soil aeration by physically blocking soil pores, leading to decreased soil microbial activity and nutrient availability (Lozano *et al.*, 2021). Recent studies have shown that microplastic pollution can have a range of negative impacts on soil physical health. For example, a study conducted in Italy found that the addition of microplastics to soil led to a decrease in soil water-holding capacity, increased soil compaction, and reduced plant growth (de Souza Machado *et al.*, 2018).

Impact of Microplastics on Soil Chemical Health

Microplastic pollution is a major environmental concern globally, with negative impacts on ecosystems and human health. While most research has focused on the impact of microplastics on aquatic environments, recent studies have shown that microplastics can also impact soil health, including soil chemical properties. The effects of microplastic pollution on soil chemical health include changes in soil pH, nutrient availability, and soil organic matter, among others.

One of the most significant impacts of microplastic pollution on soil chemical health is the alteration of soil pH. Microplastics can increase the acidity of soil by releasing acids during their degradation, leading to a decrease in soil pH (Zhao *et al.*, 2021). This can have significant implications for soil microbial activity and nutrient availability, as many soil microorganisms are sensitive to changes in soil pH. Additionally, microplastics can also alter nutrient availability in the soil. Studies have shown that microplastics can adsorb nutrients such as nitrogen, phosphorus, and potassium, reducing their availability for plant uptake (Dong *et al.*, 2021).

This can result in decreased plant growth and productivity, leading to a negative impact on agricultural productivity and food security. Furthermore, microplastics can also affect soil organic matter, which is critical for soil fertility and productivity. Studies have shown that microplastics can adsorb organic matter, reducing the amount of available organic matter in the soil (Shi *et al.*, 2022). Soil organic matter is critical for soil nutrient cycling, water retention, and microbial activity, so a decrease in organic matter can have significant negative impacts on soil health and productivity. A study conducted in China found that the addition of microplastics to soil led to a increase in soil pH and a reduction in soil organic matter, leading to a negative impact on soil microbial activity and nutrient availability (Zhao *et al.*, 2021).

Impact of Microplastics on Soil Biological Health

Microplastic pollution is a growing environmental concern that can have a range of negative impacts on soil biological health. Soil biota, including bacteria, fungi, protozoa, nematodes, and arthropods, play crucial roles in soil nutrient cycling, organic matter decomposition, and soil ecosystem functioning. Microplastics can affect soil biological health by altering the composition and diversity of soil microbial communities, disrupting soil food webs, and affecting soil nutrient cycling. One of the most significant impacts of microplastic pollution on soil biological health is the alteration of soil microbial communities. Microplastics can impact soil microbial communities by clogging soil pores, reducing soil aeration, and altering soil water-holding capacity. This can lead to changes in soil microbial diversity and composition, which can impact soil nutrient cycling and organic matter decomposition (de Souza Machado *et al*., 2018). Furthermore, microplastics can also impact soil food webs. Soil food webs are complex networks of interactions between soil biota, including predators, prey, and decomposers. Microplastics can disrupt soil food webs by altering the availability of soil organic matter, which can impact soil nutrient cycling and soil ecosystem functioning (Sajjad *et al*., 2022). This can ultimately lead to decreased soil fertility and productivity. Additionally, microplastics can also affect soil nutrient cycling. Soil nutrient cycling is a critical process that involves the transformation of nutrients between organic and inorganic forms. Microplastics can impact soil nutrient cycling by altering soil microbial communities and disrupting soil food webs (Li *et al*., 2022). This can lead to reduced nutrient availability, which can negatively impact plant growth and productivity. A study concluded that microplastics reduced soil microbial biomass and activity, leading to decreased soil nutrient availability (Blöcker *et al*., 2020). Similarly, a study conducted in Italy found that the addition of microplastics to soil led to changes in soil microbial community composition and decreased soil enzyme activity (Santini *et al*., 2023).

Mitigating the Impact of Microplastic Pollution in Soil

To mitigate the impact of microplastic pollution in soil, several measures can be taken, including:

1. Reducing plastic waste: The most effective way to mitigate the impact of microplastic pollution in soil is to reduce plastic waste. This can be achieved by using less plastic, recycling more, and promoting the use of biodegradable alternatives.

2. Proper disposal of plastic waste: Proper disposal of plastic waste is essential to prevent it from entering soil ecosystems. Landfills should be properly managed to prevent plastic waste from degrading and releasing microplastics into the environment.

3. Alternative mulching materials: Alternative mulching materials, such as biodegradable mulches made from plant-based materials, can be used in agriculture to reduce the use of plastic mulch.

4. Monitoring and regulation: Monitoring and regulating the use of plastics in various industries, such as cosmetics and textiles, can help to reduce the amount of microplastics entering soil ecosystems.

5. Remediation techniques: Techniques such as soil washing, phytoremediation, and bioremediation can be used to remove microplastics from soil.

Conclusion

Microplastic pollution in soil is a growing environmental concern that requires urgent attention. Microplastics can enter soil ecosystems through various pathways, including the direct disposal of plastic waste, the use of plastic mulch in agriculture, and the application of sewage sludge to soil. The impact of microplastic pollution in soil is not yet fully understood, but there is growing evidence to suggest that it can have adverse effects on soil health and the wider ecosystem. To mitigate the impact of microplastic pollution in soil, measures such as reducing plastic waste, proper disposal of plastic waste, alternative mulching materials, monitoring and regulation, and remediation techniques can be taken. By taking these measures, we can work towards reducing the impact of microplastic pollution in soil and protecting soil health and ecosystem functioning.

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Identification of Marker Genes for Sex Identification in Insects

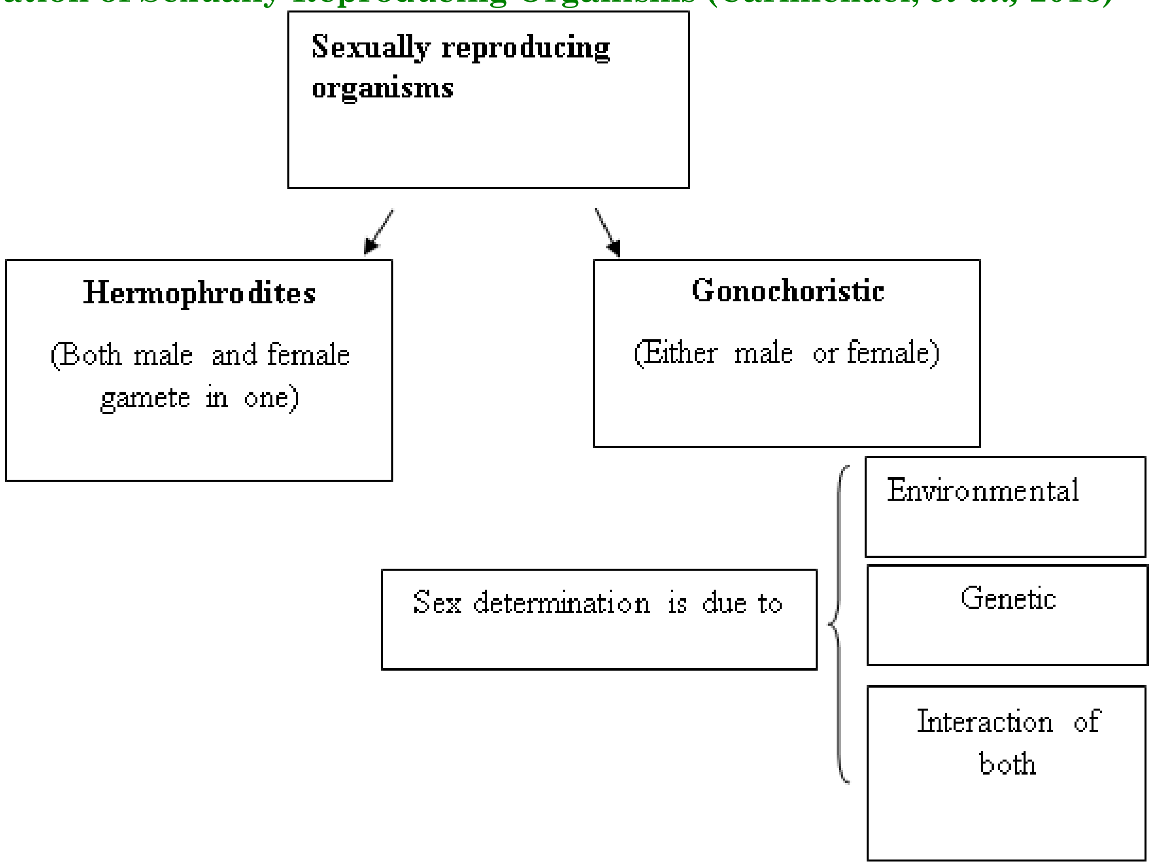
Article ID: 40770

Chandana C R[1]
[1]Ph. D Scholar, Department of Entomology, University of Agricultural Sciences, Raichur, Karnataka – 584104.

Introduction

A genetic marker is a gene or DNA sequence with a known location on a chromosome that can be used to identify species or individuals. The characters which can be easily identified are called marker characters. Sexual reproduction is an evolutionary feature. Recombination of chromosomes from two parents can result in the emergence or the loss of genes during meiosis. For sexual reproduction, sexes are prerequisites and the sex determination systems are very diverse. Over the course of evolution, different types of sex chromosomes and different sex-determining genes have been developed.

Classification of Sexually Reproducing Organisms (Carmichael, *et al.,* 2013)



Sex Determination in Insects (Blackmon *et al.,* 2017)

1. Male heterogamety (XX/XY) - In male heterogamety, females are homomorphic (XX) and males have heteromorphic sex chromosomes (XY). Eg: Drosophila.

2. Female heterogamety (ZW/ZZ) – In female heterogamety, males are homomorphic (ZZ) and females have heteromorphic sex chromosomes (ZW). Eg: Lepidopterans, trichopterans.

3. X or Z Autosome balance system (XX/XO) or (ZZ/ZO) - Here females carry a single X or Z chromosome and males carry 2 X's or 2 Z's. Eg: Many orthopterans.

4. Haploid-diploid system or Arrhenotoky - Males developed from haploid (n) unfertilized eggs and females from diploid (2n) fertilized eggs. Eg: Hymenopterans.

Sex Identification in Insects

Insects are sexually-dimorphic morphologically, physiologically, behaviorally and life-history traits (Mowrey and portman, 2012).

1. Morphological traits: Wing size and shape, size and colour of pigment patches, the size ratio of body parts, colour and density of body hairs, the shape of sensory structures, size and shape of genitalia and pheromone-releasing structures (Allen *et al.,* 2011).

2. Physiological traits: In night-flying insects, the female is signalling sex which releases a sex pheromone at night to call male (elaborate antennae) and in day-flying insects, the male is signalling sex which displays its UV-reflective wings to attract visual-signal receiving females for mating (Allen *et al.,* 2011).

3. Behavioral traits: Generally, males are smaller than females in body size but emerge earlier than the latter (male protandry) (Teder, 2014).

4. Life history: In most insects, larger females also have a longer lifespan than smaller males (Fox *et al.,* 2020).

Though sex determination takes place genetically upon fertilization and developed in embryogenesis most of the above said sexual differences are uncovered in pupal and adult stages (Biedler and Tu, 2016) as most insects do not exhibit sexual dimorphism before pupation, therefore their eggs and larvae are often morphologically indistinguishable.

Marker Genes for Sex Identification in Insects

Need for a reliable method to sex eggs and larvae/nymph for theoretical and applied research like

1. Molecular mechanisms for sexual trait development (Prakash and Monteiro, 2016).
2. Genetic control of insect pests (Andres *et al.,* 2007).

Methods to Identify the Sex of Morphologically Indistinguishable Stages Involve

1. Flow cytometry measurement of DNA content (Aron *et al.,* 2003).
2. Microscopic observation of sex chromatin (Fukova *et al.,* 2005).
3. Quantitative PCR (qPCR) measurement of the copy number of conserved Z chromosome gene in Lepidoptera (Belousova *et al.,* 2019).

Most Reliable Tool for Sex Identification

PCR gel analysis of sex-specific DNA markers revealed by RAPD (random amplified polymorphic DNA) assays or sex-specific chromosome (Y- or W-) unique DNA sequences identified by comparison of male vs. female genome sequences (Koerich *et al.,* 2016). The PCR-based sexing method is available for *Ceratitis capitata* (Douglas *et al.,*2004), *Cydia pomonella* (Fukova *et al.,* 2009), *Tribolium castaneum* (Lagsiz *et al.,* 2010) and *Gnatocerus cornutus* (Gotoh *et al.,* 2016).

Heideman *et al*., 2010 carried a research work to identify the sex of Sugarcane borer, *Diatrea sachharalis* using the molecular marker, RAPD GyakuU-13, involved in sex identification of silkworm, *Bombyx mori* and this study revealed that there is a binding of fragment profile where atleast one fragment will be related to sexual identity in the case of *D. saccharalis.* Further these observations concluded that the GyakuU-13 can be used in *D. saccharalis* as a sex-specific molecular marker. This marker gene sequence is asscociated with repititions in genome and also it is not surprising that the obtained result is different with *D. saccharalis.* Amplification of ~700 bp was detected only in females of *D. saccharalis* by using the RAPD GyakuU-13 primer. In control (*Bombyx mori* DNA), where fragment of ~600 bp was detected only in female DNA of *B. mori.*

Conclusion

Sex-specific makers are useful in the identification of sex chromosome systems and helpful especially in insects as it has heteromorphic sex chromosomes. In this regard marker genes are a powerful tool to uncover the sex chromosome systems of non-model insect species also, in a rapid and cost-effective way.

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Seed Demand, Supply and Pricing

Article ID: 40771

Nivethitha. M[1]

[1]Ph.D Scholar, Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu - 641 003.

Introduction

Increased production of agricultural crops depends not only on the development of higher yielding varieties of seeds but also on the efficiency of the systems available to ensure that these seeds reach the farmer on time. Effective seed marketing is thus an essential component of activities to improve food security. Seed marketing should aim to satisfy the farmer's demand and supply reliable range of improved seed varieties of assured quality at an acceptable price.

Marketing

A well-defined sequence of events has to take place to promote the product and to put it in the right place, at the right time and at the right price for a sale to be made. Marketing is not only in terms of the advertising and selling of goods, whereas in reality marketing starts long before the goods exist and continues long after they are sold. Therefore, for the marketing process to be successful: the farmer consumer's needs must be satisfied; the seed company's objectives must be realized.

Forecasting Demand

The first step in demand forecasting is to calculate the existing requirement x percent bought seed) is the number of commercial seed that is purchased by farmers. In calculating seed requirement, seed multiplication rates must be taken into account, i.e., Seed Multiplication Ratio is the ratio at which the seed multiplies. It is also important to define the various categories of seed that exist in the market, assist in the assessment of demand. Seed can be categorized as being: Grain retained on farm and used as seed; Grain bartered for seed at village or neighbor level; Grain sold as unlabelled seed bought from a market or trader; Certified or labeled seed bought from the distribution system.

Demand

Demand, to the seed seller, is the **quantity that buyers are willing and able to purchase at a particular price**. This is called effective demand and is not the same as the seed requirement. It is important to distinguish between the number of seed farmers will actually buy and how much they would like to buy, or indeed how much the government would like them to buy. The total amount of certified or labelled seed sold may be quite a small proportion of the total requirement.

Factors to be Considered -Assessing and Forecasting Demand

Total cultivated acreage, Seed rate and SRR, Time of sowing, Promotion activities, Competitors (number and size), Amount of seeds sold in the last year, Preferences for varieties package size, kind of packing, quality and price, Kind of publicity and sales promotion, Climate of the area where seed is being marketed, Dealers must make periodic survey of the market areas, to determine the market potential, at least one season in advance, Marketing intensity(number of markets), Rate of adoption of new technology, Govt. policies, Price.

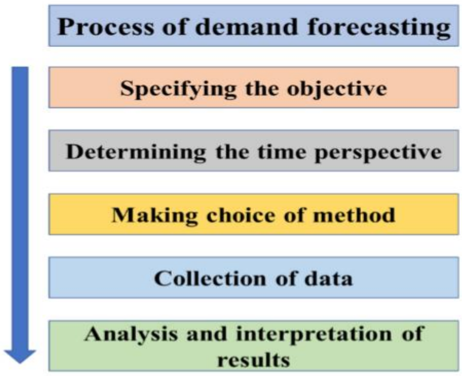
Seed Demand Fore Casting

It is an anticipation of required quantity of seed on the open market by understanding the behavior of consumers and other factors.

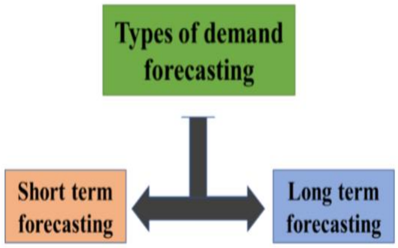
Why Demand Forecasting?

Planning and scheduling seed production, Acquiring inputs, Making provision for finances, Formulating pricing strategy, Planning advertisement.

Steps in Demand Forecasting



Types of Seed Demand Forecasting



1. Short-Term Forecasting: Short period, Forecasting short-term financial requirements Ex: - seed production.
2. Long-Term Forecasting: Planning of a new unit or expansion of an existing unit, Planning Long-Term Financial Requirements, Planning manpower Requirements.

Demand Forecasting Techniques

Target setting, Growth trends, Growth rates adjusted for new technology adoption, Sampling, Experts opinion, Survey, Market experiments, Time series analysis, Barometric analysis.

Role of Demand Forecasting on Seed Marketing

Predict the future price and need, without proper predicting it may lead to loss, It's the most important step in planning, eliminate of artificial demand, Avoid monopoly in market.

Importance of Price

Price has different meanings for different groups of people: ***To the buyer*** price is a cost which is used as a measure of value; the buyer evaluates one variety or source of seed against the alternatives; ***To the seller*** price is revenue and therefore a key element in the marketing mix; setting the right price is an important tactical decision and is a key factor influencing revenue and profit; ***To a government*** price may mean popularity and votes and is therefore a sensitive political issue; governments may therefore seek to influence and control seed pricing.

Pricing Policy

Seed pricing involves setting prices when a new product is launched or a new distribution channel is used. Also, decisions may need to be taken to change the price in response to competition and to the general market situation. In the public sector prices are often based on an economic pricing policy. Economic pricing considers the effect of seed price on the economy, taking into account the amount officials think farmers can afford to pay and the role of the seed industry in the development of agricultural production. Ideally, however, the public sector should follow a more commercial pricing policy which accounts for all costs and allows for an element of profit.

Pricing Strategies

Low price strategy, Market price strategy, High price strategy.

Pricing Techniques

Cost plus Pricing, Contribution pricing, Competitive Pricing, Short-term pricing techniques.

India's Current Status

The Indian domestic vegetable seed industry is expected to double, to around USD 1,179 million, over the next five years. According to ICRA, this growth is expected to be driven by increased use of hybrid seeds. The number of hectares under biotech crop production increased from 179.7 million, to about 185.1 million. Developing countries accounted for around 54% of the global biotech hectares, compared to the 46% of industrial countries. The increasing awareness regarding the consumption of vegetables, in order to meet diverse dietary and nutritional needs, has caused a rise in the demand for vegetables. Among all the vegetable seeds, **cabbage (100%) and tomato (99.3%)** account for the highest seed replacement rate. Currently, only 20% seeds used by the farmers are of good quality, whereas, the remaining 75% of demand is being catered to by the saved seeds of farmers, from the previous season.

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Insect Growth Regulators for Insect and their Activity for Insect Pest Control

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Mangal Sukhi Meena[1], Ankur Kulhari[2], Paparam[3]
[1,2]Department of Entomology, Rajasthan College of Agriculture, MPUAT Udaipur (Raj.) India
[3]Department of Horticulture, School of Agricultural Science and Technology, BBAU, Lucknow, U.P., India.

Introduction

A new approach to insect pest control is the use of substances that adversely affect insect growth and development. These substances are classified as "insect hormone mimics" or "insect growth regulators" (IGRs) owing to their effects on certain physiological regulatory processes essential to the normal development of insects or their progeny. They are quite selective in their mode of action and potentially act only on target species. The action of IGRs, however, should not be confused with other synthetic insecticides, such as organophosphates and carbamates, since these chemicals interfere with other physiological processes but do not regulate the development of normal insects. An IGR, therefore, does not necessarily have to be toxic to its target, but may lead instead to various abnormalities that impair insect survival (Siddall, 1976).

Insect Growth Regulators and their Activity for Insect Pest Control

Name Activity respectively: Bistfluron- Chitin synthesis inhibitor, Buprofezin- Chitin synthesis inhibitor, Chlorfluazorun- Chitin synthesis inhibitor, Cyromazine- Chitin synthesis inhibitor, Diflubenzuron- Chitin synthesis inhibitor, Flucycloxuron- Chitin synthesis inhibitor, Flufenoxuron- Chitin synthesis inhibitor, Hexaflumuron- Chitin synthesis inhibitor, Lufenuron- Chitin synthesis inhibitor, Noyaluron- Chitin synthesis inhibitor, Noyiflumuron- Chitin synthesis inhibitor, Penfluron- Chitin synthesis inhibitor, Teflubenzuron- Chitin synthesis inhibitor, Triflumuron- Chitin synthesis inhibitor, Epofenonane- Juvenile hormone mimic, Fenoxycarb- Juvenile hormone mimic, Hydroprene- Juvenile hormone mimic, Kinoprene- Juvenile hormone mimic, Methoprene- Juvenile hormone mimic, Pyriproxyfen- Juvenile hormone mimic, Triprene- Juvenile hormone mimic, Juvenil hormone I- Juvenile hormone anolog, Juvenil hormone II- Juvenile hormone anolog, Juvenil hormone III- Juvenile hormone anolog, Chromafenozide- Molting hormone agonist, Halofenozide- Molting hormone agonist, Methoxyfenozide- Molting hormone agonist, Tebufenozide- Molting hormone agonist, α-ecdysone- Molting hormone anolog, Ecdysterone- Molting hormone anolog, Diofenolan- Molting inhibitor.

Major Groups of Insect Growth Regulators

Since the target sites of common insecticides on insects and mammals are known to be similar, it is desirable to develop insecticides whose primary target site does not exist in mammals for selective toxicity. IGRs may belong to this type of (selective) insecticides and can be grouped according to their mode of action, as follows: chitin synthesis inhibitors (i.e. of cuticle formation) and substances that interfere with the action of insect hormones (i.e. JHs, ecdysteroids) (Table 1). Chitin synthesis inhibitors The insect cuticle serves as an interface between the living animal and its environment; and forms the exoskeleton, supporting the linings of the gut, respiratory systems, reproductive ducts, and some gland ducts. It consists primarily of protein and chitin fractions. The latter comes in 3 forms, α, β, and γ chitin, and is the β-(1,4) glycoside polymer of N-acetyl-D-glucosamine. In additional to the insect and crustacean cuticles, chitin is present in cell walls of fungi and protozoa, but is absent in vertebrates and higher plants. Synthesis of chitin depends on the action of the extra cellular enzyme chitin synthesis attached to the plasma membrane. However, this enzyme is produced as a zymogen (inactive) in the endoplasmic reticulum of the epidermis and has to be activated by proteases for chitin synthesis (Hepburn, 1985). Since proteases are important for activating chitin synthesis zymogens, these enzymes become potential targets for regulation by certain compounds, along with other key regulatory steps in the biosynthesis of chitin. The first chitin synthesis inhibitor introduced into the market as a novel insecticide was benzoylphenylurea, diflubenzuron (Figure, 1a) (Miyamoto et al., 1993). It was considered a potent compound against larvae of common cutworm, Spedoptera litura (Fabr.) and Cydia pomonella L. (Miyamoto et al., 1993). Some of the structural modifications (derivatives) of the compound are more active than the parent compound. Aside from Lepidoptera, diflubenzuron has also been effective against Coleoptera and Diptera (Göktay and Kısmalı, 1990). Diflubenzuron and its derivatives were effective against insect pests and mites infesting field crops, and were relatively harmless to beneficial insect species. On the other hand, buprofezin, another chitin synthesis inhibitor, was used against homopteran pests including nymphs of brown planthoppers, Nilaparvata lugens (Stal.), leafhoppers, Nephotettix cincticeps (Uhler), whiteflies, Bemisia tabaci (Gennadius), and scale insects, Trialeurodes vaporariorum (Westwood), attacking fruit crops and certain species of Coleoptera and Acarina (Asai et al., 1985; Elsworthip and Martinez, 2001). Lefunuron, an orally administrated chitin synthesis inhibitor, was also used against fleas (Smith, 1995), and it inhibited chitin synthesis and influenced the development of eggs and larvae. Female fleas biting lufenuron-treated animals produced infertile eggs as well as inhibiting larval development when feeding on "flea dirt" that contained blood from the treated insect. This observation was probably because of lufenuron, which is not significantly metabolized and is thus excreted into the feces. Different groups of insect growth regulators, such as juvenile hormone analogues, chitin synthesis inhibitors, and one triazine derivative, were tested in a special larvicidal test. The chitin synthesis inhibitors were quite effective against multi-resistant Musca domestica strains, except for one strain with strong resistance against chitin synthesis inhibitors, developed after extensive treatments with benzoylphenylureas for several years (Pospischil et al,, 1997). Mode of action of chitin synthesis inhibitors (CSIs) Most CSIs are primarily used as larvicides. Treated larvae develop until molting, but fail to ecdyse due to inhibition of the synthesis of new cuticle, specifically, chitin biosynthesis. Diflubenzuron, for instance, when directly applied to Manduca epidermal cells in vitro, inhibited endocuticular deposition (Miyamoto et al., 1993). Moreover, chitin precursors of Pieris larvae (14Cglucose), Manduca larvae (14C-glucosamine), Mamestra larvae (14C-acetylglucosamine) and Spodoptera (Boisduval) larvae (14C-UDP-N- acetyglucosamine) were not incorporated into chitin in the presence of chitin synthesis inhibitors. Although the precise mode of action of diflubenzuron and other CSIs is still unknown, 3 hypothetical target.

Conclusion

Most synthetic insecticides are toxic to all animals including human beings. Although many insecticides can be used safely, a few are persistent in the environment and a small number have multigenic, carcinogenic and teratogenic effects on human beings and domestic animals. Furthermore their magnification in the food chain sometimes threatens non-target organisms. These facts have become of deep concern to agricultural and health scientists, producers and consumers alike. Based on the previous discussion, IGRs generally have a good margin of safety for most non-target biota including invertebrates, fish, birds, and other wildlife. They are relatively safe for human beings and domestic animals.

Acceleration and Control of India from Desertification

Article ID: 40773

Partha Mondal[1], Agnibha Sinha[2]
[1]B.Sc (Hons) Agriculture, Lovely Professional University, Punjab.
[2]Assistant Professor, Department of Soil Science, Lovely Professional University, Punjab.

Abstract

Desertification is a significant ecological issue on through the worldwide. A kind of land deterioration known as desertification, which is primarily caused by climate and anthropogenic causes, occurs in semi-arid and dry regions. India has been looking for strategies to accomplish the sustainable management of desertified areas because the country is afflicted by vast sandy desertification as well as frequent sandstorms and dust storms. In this essay, the effects of anthropogenic activity and climate change on desertified areas were discussed, along with the efforts made to stop desertification in and the results that resulted from them. In spite of localised tendencies towards heat and drying as well as increased human pressure, the trend towards desertification has been reversed generally. To stop the desertification several initiatives have been combined, including forestry and government policies, as well as growth of eco-industrialization. Arid and semi-arid ecosystems have become more balanced as a result of beneficial human intervention, such as afforestation, the restoration of movable sandy land, and water conservation. India's desertification management techniques may offer important insights for sustainable desertified land management on a worldwide level.

Keywords: Desertification, land reclamation, Improving lifestyle of small and marginal farmer.

Introduction

Land degradation is the term used to describe the decline in biodiversity and productivity brought on by the physical, chemical, and biological deterioration of the land. It has a substantial effect on the general natural ecology, human wellbeing, and the status of the global economy. As a result of significant land degradation, arid, semi-arid, and dry sub-humid conditions are created, according to the UNCCD.

Desertification is occasionally brought on by anthropogenic activities and climatic factors that cause soil erosion, a decline in soil quality, and the loss of native plants. Degraded ground increases hazard for communities by progressively reducing people's ability to use their property and limiting their access to resources.

Social tensions already present might worsen, and forced migration. India is converting more than a quarter of its land to desert (Srinidhi et al, 2017). This also pertains to the nation's degraded agricultural regions (ISRO, 2016). Satellite image analysis has revealed that around 32% of India's land is damaged, with desertification being the main culprit. A crucial element in deterioration. Nine states of the Indian Union account for around 24% of the desertification, with newer regions in Jammu & Kashmir, Odisha, and Jharkhand among those that are becoming dry.

Desertification, which indirectly impacts the entire system of living things as a whole is one of the primary environmental challenges facing the planet (Rivera-Martin et al,2022). Worst even, more than 50% of the area that is being turned into desert is located in Jharkhand, Rajasthan, Delhi, Gujarat, and Goa etc. India is a signatory to the United Nations Convention on Combating Desertification in the fight against desertification on a worldwide scale (UNCCD). It aspires to reach land degradation-neutral status through fighting desertification and land degradation.

Indian law and policy do not, however, specifically address the issue of desertification. On the other hand, many of India's national policies, including the Desert Development Programme, Integrated Wasteland Development, National Watershed Development Project for Rain-fed Areas, Soil Conservation in the Catchment of River Valley Projects, National Afforestation Programme, Arid Zone Research, Mahatma Gandhi National Rural Employment Guarantee Scheme, and National Rural Drinking Water Program, reflect the country's concern for stopping and reversing land degradation and desertification.

Objective of the Study

The reviews's goals are to:
1. Assess the process of land reclamation.
2. Analyse the utilisation of reclaimed land for agriculture, particularly by the marginal farmers and the smallholding farmers.

Degree of desertification: 304 million hectares of India's 329 million hectares of land are covered by data regarding land usage. approx 30 million hectares of the total reporting area are classed as other uncultivated territory, whileapprox 41 million hectares are used for purposes other than agriculture.66 million hectares in total are not suitable for farming. According to reports, the area used for non-agricultural activities is growing at a pace of 0.3 million hectares annually.67 million hectares are said to be designated as woods. Just 38 million hectares of the entire forest area have canopy. so that around half of the forest area is advance stage of deterioration. Although there was no information available to emphasise the regions of various bio-climatic zones, the area under the dry, semi-arid, and sub-humid zones has been determined.

State wise data on the basis of degree of desertification: the severity and breadth of the desertification risk. According to the problem's existence and severity, the map shows many elements of desertification from different views. The map demonstrates this, as may Out of 29 states, 12 states—Andhra Pradesh, Gujarat, Haryana, Jammu and Kashmir, and Karnataka—have been afflicted by the problem of desertification, which affects an area of 531870.48 square kilometres, or around 16.18 percent of the total geographical area distributed over 12 states. Uttar Pradesh, Tamil Nadu, Orissa, Punjab, Rajasthan, and Madhya Pradesh are among the other states. areas that are classed as arid, semi-arid, and dry sub-humid, along with the state-by-state location of the affected region. The table shows that the highest area affected by desertification. Arid areas make up about half of all comparable areas in Rajasthan State, whereas semi-arid areas are most prevalent in Maharashtra. Madhya Pradesh has the most sub-humid territory of any state, making it the only one that is susceptible to desertification.

State	Total Geographical Area	Semi Arid	Arid	Dry Sub Humid	Total
Jammu &Kashmir	222236.00	30862.17	------------------	9118.29	39980.46
Punjab	50362.00	6273.79	------------------	------------------	6273.79
Haryana	44212.00	4415.55	8811.99	8811.99	13227.54
Madhya Pradesh	443446.00	50032.76	-----------------	50032.76	50032.76
Uttar pradesh	294411.00	34803.94	-------------------	34803.94	34803.94
Gujarat	196024.00	18800.34	16561.24	-----------------	35361.58
Rajasthan	342239.00	23556.08	47986.78	34583.84	106126.70
Odisha	155707.00	----------------		801.38	
Maharastra	307713.00	47468.09	-------------------	23409.89	70877.98
Andra pradesh	275045.00	35754.12	-----------------	48199.14	83953.27
Karnataka	191791.00	29115.08	------------------	31002.58	60117.66
Tamil Nadu	130058.00	------------------	------------------	30313.42	30313.42
India	3287263.00	165383.05	95410.19	271077.24	531870.48

#(Area in Sq. Kms).

State Wise Desertification Process and Vulnerability

State	Desertification Process	Desertification Vulneralability

Jammu &Kashmir	In Cold Dessert soil erosion on slopes and deposition on lands are responsible for the problem	The cold desert zone is generally disturbed area due to international boundary w Soil erosion on slopesand deposition on flat lands are responsible for severity of the problem.
Punjab	Salinity and water logging is the are severe problem for loose the fertility and severity of the soil as well the state	Given that the majority of the state is covered by canals, water logging and salinity are major issues.
Haryana	In canal cultivation high alert desertification occur due to water lodging but in well irrigated prone area faced problem salinity and alkalinity	The state is very susceptible to desertification, and water logging mostly affects canal-cultivated areas.
Madhya Pradesh	Salinity and alkalinity is the severe problem for continuous lifting of ground water	Salinity and alkalinity are a serious issue brought on by the ongoing withdrawal of ground water.
Uttar pradesh	The western region of the state, which is next to Rajasthan and falls within the sub-humid zone group, is moderately susceptible to desertification.	Due to water logging and salinity in canal-cultivated regions and salinity/alkalinity in ground water-irrigated areas, desertification has occurred.

How can Desertification be Stopped?

1. At specific depths in the soil, vacant layers of sand and gravel are created as salt traps. Salt traps serve to reduce water loss by preventing salts from penetrating the soil's surface.
2. Irrigation upgrades can reduce evaporative water loss and stop salt buildup. This method includes modifying irrigation system design to stop water from collecting or quickly evaporating from the land.
3. Cover crops decrease soil erosion caused by rainfall and wind. They can also lessen the consequences of drought locally. On a bigger scale, vegetation can support the preservation of regular rainfall patterns. Perennials or quickly expanding annuals can be used as cover crops.
4. Alternating various crops on the same piece of land over a period of time is known as crop
5. Rotational grazing is a method of reducing cattle grazing pressure in a certain region. Before they permanently harm the vegetation and soil of any one region, livestock is routinely relocated to different grazing sites.
6. Terracing is the process of laying up many levels of flat land that resemble the lengthy steps that are carved into hillsides. The method lowers soil erosion and delays total water loss by slowing runoff.
7. Contour bunding and contour farming involve the placement of stone lines that follow the terrain's natural rises. These methods aid in capturing and retaining precipitation before it may become runoff. By keeping the soil wet and heavy, they also prevent wind erosion.

Measures taken by Indian Govt to Curb Desertification

Integrated Watershed Management: By using, protecting, and developing depleted natural resources while generating rural employment, it seeks to restore ecological equilibrium. Today, it falls under the NITI Ayog- implemented Pradhan Mantri Krishi Sinchai Yojana.

Program for Desert Development:

a. It was started in 1995 to lessen the negative effects of drought and to revitalise the desert areas' natural resource base.

b. It was introduced for Rajasthan, Gujarat, and Haryana's hot desert regions as well as Jammu & Kashmir's and Himachal Pradesh's cold desert regions.

UNCCD: United Nations Convention to Prevent Desertification

India ratified the UNCCD in 1996 after signing it in 1994. By 2030, India hopes to have 26 million hectares of its damaged land restored.

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Sensor Based Nitrogen Application; An Innovative Way of Nitrogen Management

Article ID: 40774

Surya Prakash Yadav[1], Abhishek Jangir[1], Rosin K.G.[2], Prabhakar Prasad Barnwal[1], Sarvendra Kumar[1]

[1]Division of Soil Science and Agricultural Chemistry, ICAR-Indian Agricultural Research Institute, New Delhi-110012.

[2]Water Technology Centre, ICAR-Indian Agricultural Research Institute, New Delhi-110012.

Introduction

Nitrogen (N) from fertilisers has emerged as the primary factor in food production. More than half of the fertiliser N consumed worldwide is used on grains including rice, wheat, and maize. According to estimations, 50–70% more cereal grain will be needed to feed the world's population of around 9.1 billion people by 2050. If the efficiency of fertiliser N recovery in cereals is not enhanced, this will lead to an even bigger increase in the demand for fertiliser N. Only 30–50% of the first crop and no more than 7–10% of subsequent crops utilize it and the remaining N is lost from the soil–plant system.

Overuse of N results in nutritional imbalances, disease and insect susceptibility in plants. In addition to raising crop production costs, low nitrogen recovery also contributes to environmental contamination. General recommendations based on fixed-time application of fertiliser N dosages at specified growth stages fail to account for the dynamic soil N supply and crop N requirements, resulting in the application of fertiliser N at the incorrect time. As a result, demand-driven, need-based fertiliser management for crops can aid in increasing the effectiveness of N recovery and lowering N losses. Using traditional tissue testing techniques, it is possible to meet the crops' in-season N requirements. Plant tissue analysis, on the other hand, takes 10-14 days from tissue sampling to receiving a fertiliser recommendation and does not appear to be a viable option. The use of leaf colour as a visual and subjective indicator of N fertiliser needs. Thus, leaf spectral properties should be used more rationally to advise need-based fertiliser N applications. The concept of using spectral reflectance ratio to quantify the colour of intact crop leaves was first reported in Japan in the early 1960s. Only in the late 1980s and early 1990s did researchers begin to focus on using tools like the leaf colour chart (LCC) (based on spectral properties of leaves) and the chlorophyll metre (SPAD metre) (based on light transmittance through leaves) to guide real-time N top dressings in rice. Significant correlations have been observed between chlorophyll content index values obtained with chlorophyll meter and foliar or whole plant N in maize (Singh and Singh, 2022). The potential of need based fertilizer N management technology using SPAD meter in maize and SPAD meter was found as helpful guide to regulate the timing of N application (Li *et al.*, 2022). Nevertheless, the SPAD meter threshold value may vary among varieties, hybrids and environmental conditions. SPAD meter is an efficient tool but being relatively expensive may not be owned by small and marginal farmers individually. Inexpensive and practically reliable alternative to the SPAD meter is the use of LCC. It has been successfully used for regulating N supply to rice and wheat. The LCC shade 4 on the six-panel IRRI-LCC has been found to be the threshold score for transplanted coarse grain rice varieties prevalent in the Indo- Gangetic plains.

Constraints of Conventional Methods

In Blanket application the efficient use of N fertiliser is hindered by large-scale field-to-field variability of soil N and poor synchronisation between soil N supply and crop demand. The cultivars often show differential response to N fertilizer application. Traditional methods not only cause plant damage, but also have sophisticated procedures and extensive analytical periods, making it difficult to identify crop N status in real time throughout growing seasons.

Why Sensors Based Technology?

To maximize profitability through improved nitrogen, use efficiency, innovative fertilizer management must include both preventive and field-specific corrective N application methods. The successful implementation of these approaches is dependent on the use of new precision agricultural technology such as on-the-go soil and crop sensors and data communication protocols between sensors, controllers, computers and databases. Real-time crop sensors have also become available utilizing passive and active light technologies to ascertain crop stress (such as N stress) through reflectance measurements in visible and near-infrared wave bands.

Sensors Based Approaches for Nitrogen Management

1. Management zone approach
2. In-season crop monitoring approach to N management
    a. Leaf color chart and chlorophyll meter sensing
    b. Arial and satellite remote sensing
    c. Ground based remote sensing
3. Integrating soil and crop sensing information into N management.

Management Zone Approach

Management zones (MZ), in the context of precision agriculture, are field areas possessing homogenous attributes in landscape and soil condition. When homogenous in a specific area, these attributes should lead to similar results in crop yield potential, input-use efficiency, and environmental impact. Approaches to delineate MZ vary, but typical procedures involve acquiring various geo-referenced data layers (i.e., topography, soil colour, electrical conductivity, yield, etc.), traditional and geospatial statistical analyses on these layers, and delineation of spatial variation from these layers into MZ, as outlined by Schepers *et al*. (2004). Soil map units, topography, remote sensing, electrical conductivity sensors, crop yield and producer experience have all been used with varying success to delineate MZ. While these data sources for MZ delineation can be used to consistently characterize spatial variation in soil physical and chemical properties that partially affect crop yield potential, they are less consistent in characterizing spatial variation in crop N requirements because of the apparent effect of temporal variation on expression of yield potential (Schepers *et al*., 2004). Therefore, the soil-based MZ concept alone will not be adequate for improving variable application of crop inputs like N, primarily because it does not address weather-mediated variability in crop N demand.

In-Season Crop Monitoring Approach to N Management

1. Leaf color chart and chlorophyll meter sensing: The leaf colour chart (LCC) is a simple and low-cost diagnostic tool for measuring the relative greenness of rice leaves as an indicator of plant N status. The LCC is used to calculate the N fertiliser requirements of rice crops. LCC has four green strips ranging in colour from yellow green to dark green. It determines the greenness of the rice leaf, which indicates the amount of nitrogen it contains. Rice leaf N status is closely related to photosynthetic rate and biomass production, and it is a sensitive indicator of crop N demand changes during the growing season. A tool to rapidly assess leaf N status and thereby guide the application of fertilizer N to maintain an optimal leaf N content can consequently be vital for achieving high rice yield with effective N management.

Chlorophyll metre provides a quick and non-destructive method for estimating leaf N content; its high cost prevents farmers from using it. The SPAD-502 metre is a hand-held device that is widely used for measuring leaf chlorophyll concentrations in a quick, accurate, and non-destructive manner. The concentration of chlorophyll in the leaves is an important parameter that is frequently measured as an indicator of chloroplast development, photosynthetic capacity, leaf nitrogen content, or overall plant health. It measures leaf transmittance in the red (650 nm) and infrared (940 nm) regions of the electromagnetic spectrum. The gadget uses these transmittance values to calculate a relative SPAD metre value that is proportionate to the amount of chlorophyll in the sample and is normally between 0 and 50 (Ling *et al*., 2010). When the Chlorophyll meter readings fell below 95% of the metre values, nitrogen stress and grain production losses were observed to occur, which implies that the 95% value (known as a "sufficiency index") would be a reasonable "trigger point" to apply more N.

2. Arial and satellite remote sensing: Remote sensing – the process of acquiring information about objects from devices not in contact with those objects – is an option for obtaining information on crop N status for portions of or an entire field. Plants with increased levels of available N typically have greater leaf N concentrations and more chlorophyll. Chlorophyll in leaves absorbs most strongly in the blue (450 nm) and red (670 nm) light, and reflects in the green (550 nm) region of the light spectrum. One potential advantage of remote-sensing imagery is that it is not limited by sampling interval or geo-statistical interpolation, as has been implied for grid-sampled soil test data.

3. Ground based remote sensing: Ground-based crop canopy reflectance sensing, technically a type of remote sensing, has also been used to assess crop N condition and determine N input recommendations. Unlike aerial or satellite sensing, ground-based sensing need not be compromised by clouds and the sensors can be attached directly to an applicator so that the fertilization can be accomplished within seconds of crop sensing. The hand-held GS 505 is a Ground-based active-optical sensor, which, unlike the chlorophyll meter, measures reflected light. The GS has significant advantages over the chlorophyll meter, satellite images and aerial photographs in managing corn N nutrition at a field scale including that it is faster and less labour-intensive than the chlorophyll meter. The GS also does not require a full canopy or ultra-high resolution as do aerial photographs. The GS is an "active proximal" sensor, not limited by cloud cover or diurnal variation, and emits the light that is measured upon reflectance back to the sensor (Kitchen *et al.*, 2010). The light emitted at two different wavelengths, red 670 nm and NIR 780 nm, have related mainly to canopy biomass and photosynthetic capacity (Kitchen *et al.*, 2010). Reflected red radiation always negatively correlated with canopy photosynthetic activity, whereas the NIR reflectance always positively related to canopy biomass. Nitrogen deficient plants often exhibit higher levels of reflectance in the visible (400–700 nm) portion of the spectra due to reduced photosynthetic activity, and lower reflectance levels in the NIR (>700 nm) region explained by the reduced leaf surface area in the N-stressed plants.

Conclusions

Good correlation between SPAD readings and LCC values suggested that LCC can be used as a practical tool for farmers for assessing the leaf N status and for managing N fertilization. Chlorophyll Meter readings are a good predictor of yield response to N over a wide range of soil types, geography, landscape forms, weather environments, and management practices, and would be useful in making N-fertilizer management decisions. The LCC-based N management assures high yields consistent with efficient N use enhancing total productivity and farmer's profit. Crop reflectance measurements using optical sensors can be used to set more efficient and profitable N fertilization levels.

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Risk Assessment on Soil Health of Punjab

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Sivasakthi S[1]
[1]B.Sc. Hons Agriculture, Lovely Professional University, Punjab.

Abstract

This review article examines the current status of soil health and contamination and its risk assessment in India. The impacts of soil contamination on human health, the environment, and agricultural productivity are also addressed. Risk assessment methodologies, government policies and regulations, and research directions for future interventions are also analyzed. The article concludes with recommendations for reducing the risk of soil contamination and protecting human health and environment. Overall, this review highlights the importance of understanding and managing the potential negative impacts of soil contamination through risk assessment.

Keywords: Soil contamination, Heavy metals, Health risks, Soil Health.

Introduction

Soil health is an important factor for sustainable agriculture and food security. However, the intensive agricultural practices, industrialization, and urbanization in the region have led to various forms of soil contamination and degradation, threatening the productivity of our sustainable natural resources. This review article aims to examine the current state of soil health and contamination in Punjab, its sources, impacts, and risk assessment methodologies specific to the region. The article also presents recommendations for reducing the risk of soil contamination and protecting human health and the environment in the specific context of Punjab.

Source of Soil Contamination

Indiscriminate use of fertilizers: The majority of the essential nutrients like nitrogen, phosphorus, potassium, calcium, magnesium, sulfur and more must be obtained from the soil. Farmers generally use fertilizers to correct the soil deficiencies. The excess use of chemical fertilizer contaminates the soil health heavily.

Indiscriminate use of pesticides, insecticides, and herbicides: All the cultivable crops are continuously infected by insects, and other animals. To kill the weeds farmers often use the chemical like weedicide. The excess use of DDT and Gammaxene made the insects to become resistant to DDT as it doesn't decompose readily, it persists in the environment for longer periods of time and affect the health and quality of the soil.

Heavy metals: Heavy metal contamination refers to the excessive deposition of toxic heavy metals in the soil. Heavy metals in the soil include, such as mercury (Hg), cadmium (Cd), lead (Pb), chromium (Cr) and arsenic (As). The level of heavy metal contamination in the soil is analyzed and determined by geoaccumulation index (Igeo), which was established by Muller. geoaccumulation index is obtained by comparing the contamination levels before and after contamination.

Impacts of Soil Contamination on Human Health and Environment

Effect on Growth of Plants: The extensive contamination of the soil has a negative impact on the ecological equilibrium of any system, which in turn has repercussions for the growth and development of plants. Most plant species are unable to adjust when there is such a rapid shift in the physical, chemical, and biological qualities of the soil in such a short amount of time. As time passes, the fertility of the soil decreases, rendering the land unfit for agriculture.

Effect on Human Health: It would indicate that people who are subjected to higher levels of pesticides are at a higher risk of developing non-Hodgkin lymphoma. There is also evidence that pesticides cause brain tumors in children whose parents were exposed to high doses of pesticides when they were younger. Although some researchers have found a correlation between pesticides and breast cancer and benign breast alterations, other studies have found a link between pesticide exposure and kidney cancer and pancreatic cancer.

Decreased Soil Fertility: The presence of toxic substances in the soil leads to reduction in soil fertility, which in turn reduce the crop yield. Polluted soil utilized for producing agriculture crops like fruits, vegetables which are poor in nutritional value and cause health issues among the people who consume them.

Risk Assessment Methodologies

Hazard Identification: This is the first step in the risk assessment process and involves identifying the specific contaminants present in the soil and the potential hazards they pose to human health and the environment.

Risk Management: This step involves developing and implementing interventions to reduce the risk of soil contamination and protect human health and the environment.

Monitoring and Evaluation: This step involves monitoring the effectiveness of the interventions implemented and evaluating the need for any additional actions.

Future Intervention and Regulations

Development of sustainable agricultural practices: This can include promoting integrated pest management, reducing the use of chemical fertilizers and pesticides, and promoting crop rotation and other conservation practices.

Proper waste management: This includes proper treatment and disposal of hazardous and industrial waste and sewage to prevent soil contamination.

Use of remote sensing and advanced analytical techniques: This can help in identifying and mapping areas of soil contamination, monitoring the effectiveness of interventions and providing early warning of potential hazard.

Strict enforcement of laws and regulations: This is important to ensure compliance with regulations and best management practices, and to hold polluters accountable for their actions.

GEO ACCUMULATION INDEX

Geoaccumulation index	Classification	Level of contamination
$5 < I\ geo \leq 10$	6	Extremely serious
$4 < I\ geo \leq 5$	5	Strong to extremely serious
$3 < I\ geo \leq 4$	4	Strong
$2 < I\ geo \leq 3$	3	Moderate to Strong
$1 < I\ geo \leq 2$	2	Moderate
$0 < I\ geo \leq 1$	1	Light to moderate

(Muller G et al., Geo Accumulation Index (1969))

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$0 < I\ geo \leq 1$	1	Light to moderate

(Khurana et al., (2003))

Conclusions

Soil contamination is a result of many activities and experiments done by human beings which end up contaminating the soil. Industrial wastes such as harmful gases and chemicals, agricultural pesticides, fertilizers, and insecticides are the most common causes of soil pollution. Soil pollution by different kind of pollutants is a matter of rising importance. Reclamation of contaminated soils is expensive, energy consuming and laborious, Phytoremediation may be a promising low cost alternative. Use of natural decomposition processes carries the potential to serve as a cost-efficient way to reduce the risks of contaminated soils.

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Importance of Solar Radiation in Crop Production

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Anitta Fanish S[1]

[1]Assistant Professor, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore - 641003.

Along with water and nutrients, solar radiation (sunlight) is an essential input for plant growth. Plant leaves absorb sunlight and use it as an energy source in the process of photosynthesis. A crop's ability to collect sunlight is proportional to its leaf surface area per unit of land area occupied, or its "leaf area index (LAI)". At "full canopy" development, a crop's LAI and ability to collect available sunlight are maximized. From full canopy through the reproductive period, any shortage of sunlight is potentially limiting to corn yield. When stresses such as low light limit photosynthesis during ear fill, corn plants remobilize stalk carbohydrates to the ear. This may result in stalk quality issues and lodging at harvest. The most sensitive periods of crop growth (e.g., flowering and early grain fill) are often the most susceptible to stresses such as insufficient light, water or nutrients The importance of the solar radiation for the crop production process is understand especially on general level i.e. that solar energy is the driving force and only source of energy for photosynthesis (Penning de Vries et al., 1989). The utilization of solar energy for photosynthetic activity is limited by low content of carbon dioxide in air especially during clear summer days, by unsuitable canopy structure (mutual shading of leaves) and by lack of water or (and) minerals. Solar radiation (SRAD) is one of the main factors influencing biomass and yield production and its quality e.g. high 1000-grain weight is beside other factors associated with prolonged SRAD in the phase of stem elongation and grain filling while low intensity of SRAD during grain filling phase negatively influences grain yield.

What is Solar Radiation?

Solar radiation is the set of electromagnetic radiation emitted by the Sun. The Sun behaves almost like a black body which emits energy according to Planck's law at a temperature of 6000 K. The solar radiation ranges go from infrared to ultraviolet. Not all the radiation reaches Earth's surface, because the ultraviolet wavelengths, that are the shorter wavelengths, are absorbed by gases in the atmosphere, primarily by ozone. Solar radiation is radiant (electromagnetic) energy from the sun. It provides light and heat for the Earth and energy for photosynthesis. This radiant energy is necessary for the metabolism of the environment and its inhabitants. The three relevant bands, or ranges, along the solar radiation spectrum are ultraviolet, visible (PAR), and infrared. Of the light that reaches Earth's surface, infrared radiation makes up 49.4%, while visible light provides 42.3%. Ultraviolet radiation makes up just over 8% of the total solar radiation. Each of these bands has a different impact on the environment. The atmosphere acts as a filter to the bands of solar spectrum, and at its different layers as solar radiation passes through it to the Earth's surface, so that only a fraction of it reaches the surface. The atmosphere absorbs part of the radiation reflects and scatters the rest some directly back to space, and some to the Earth, and then it is irradiated.

Types of Solar Radiation

The total solar radiation, often called as global radiation is the sum of direct, diffuse and reflected radiation. The solar radiation available to us is always a mix of the above mentioned three components. The actual percentage of each of these components varies as the different parameters, such as weather, location etc. change. In order to monitor and analyze the performance of solar plants, monitoring the global radiation is essential but depending upon the plant capacity and location, monitoring the composition of global radiation might also make sense.

Solar radiation on the earth can be classified as:

Direct radiation: This radiation comes directly from the sun without any change in its direction. This type of radiation is characterized by projecting defined shadow onto the objects that intersect. Direct radiation is received from sun rays travelling in a straight line from sun to the earth. Direction radiation is also termed as beam radiation or direct beam radiation. As direct radiation is sun rays travelling in a straight line, shadows of the objects which come in the way of sun rays are formed. Shadows indicate the presence of direct radiation. In sunny regions and during summers, direct radiation accounts for almost 70-80% of the total radiation present. In solar plants, solar tracking is implemented to absorb most of the direct radiation. If solar tracking system is not installed, valuable direct radiation would go un-captured.

Diffuse radiation: This radiation comes from all over the atmosphere as a result of reflection and scattering by clouds, particles in the atmosphere, dust, mountains, trees, buildings, the ground itself, and so on. Global radiation: Is the total radiation. It is the sum of the two radiations above. On a clear day with a clear sky, the direct radiation is predominant above the diffuse radiation. Direct radiation has a fixed direction. Diffuse radiation does not have any fixed direction. When sun rays are scattered by particles present in the atmosphere, these scattered sun rays account for the diffuse radiation. Shadows of the objects will not form if only diffuse and no direct radiation is present. As pollution increases, the amount of diffuse radiation also goes up. In hilly regions and during winters, the percentage of diffuse radiation goes up. Maximum amount of diffuse radiation is captured by the solar panels when they are kept horizontally. This means, in case of solar panels which are at an angle to track the most of the direct radiation, the amount of diffused radiation captured by the panels will go down. Larger the angle which solar panels make with the ground, lesser would be the quantity of diffuse radiation captured by the panels.

Reflected radiation: Reflected radiation is the component of radiation which is reflected from surfaces other than air particles. Radiation reflected from hills, trees, houses, water bodies accounts for reflected radiation. Reflected radiation generally accounts for a small percent in the global radiation but can contribute as much as 15% in snowy regions.

Basic Principles to Harvest

Solar energy provides light required for seed germination, leaf expansion, growth of stem and shoot, and flowering, fruiting and thermal conditions necessary for the physiological functions of the plant. Solar radiation plays an important role as regulator and controller of growth and development. Solar radiation also influences assimilation of nutrient and dry matter distribution. Some of the management practices are:

1. Optimum time of sowing
2. Optimum plant population
3. Timely application of fertilizers
4. Irrigation management etc. are aimed at increasing the interception of solar radiation by the foliage so as to get more yield.

Importance in Crop Production

The amount and intensity of solar radiation that a location or body of water receives depends on a variety of factors. These factors include latitude, season, time of day, cloud cover and altitude. Not all radiation emitted from the sun reaches Earth's surface. Much of it is absorbed, reflected or scattered in the atmosphere. At the surface, solar energy can be absorbed directly from the sun, called direct radiation, or from light that has been scattered as it enters the atmosphere, called indirect radiation. It has important impacts on plant growth and development. It will directly influence the plant plant physiological, biochemical and morphology such as photosynthesis, respiration and transpirational effects on water and nutrient uptake.

Effects of Radiation on Plants

1. Ultraviolet radiation affects plant growth and sprouting and the amount of damage is proportional to the radiation received. Due to radiation exposure soil can become compact and lose the nutrients needed for plants to grow.

2. Radiations disrupt the stomatal resistance. The stomata are a small air hole within the plant leaf that also controls water levels. If there is too much evaporation due to intense radiation the stomata close to reserve water. If the stomata are unable to open for a long period of time, the growth of the plant is stunted. Prolonged exposure to radiation can completely damage the stomata and ultimately the plant is destroyed.

3. Plant cells, contain chromosomes i.e. the genetic material responsible for plant reproduction if the ceil is much damaged by radiation then reproduction is hindered. As UV radiations destroy cells, the chances of mutation are increased. Affected plants are often small and weak with altered leaf patterns.

4. Prolonged radiation exposure can completely destroy the fertility of plant and the plant gradually dies.

Direct Effects

1. Chromosomal aberrations, defined as visually observable changes in chromosome structure.
2. DNA damage, defined as any damage to DNA molecules, including DNA sequence "inversion" (TCAG now GACT) as well as sections of sequences being "deleted".
3. Growth reduction, defined as a reduction in the rate of growth of organisms.
4. Reproduction effects, including sterility, reduction in reproduction rate, and occurrence of developmental abnormalities or reduction in viability of offspring.
5. Reduced seed germination.
6. Mortality, including both acute lethality and long-term reduction in life span.
7. Direct burn damage to exposed tissue.
8. The amount that a plant, or any organism, is affected by radiation is determined by how much radiation the organism receives, as well as long it is exposed.

Indirect Effects

Direct contact with radiation or radioactive materials is not required to affect local plant life; the mere presence of a reactor is often enough. To build a nuclear reactor, one requires a great deal of space, usually near water, which means clearing out any local vegetation. Heat given off by the reactor can change nearby water temperature, disturbing the delicate conditions required for coastal vegetation.

Factors Affecting Solar Radiation

There are 3 major factors are given below as:

1. Climatic factors:
- a. Summer
- b. Winter
- c. Weather

2. Plant factors:
- a. Plant species
- b. Plant canopy
- c. Leaf arrangement
- d. Plant type

3. Edaphic factors:
- a. Soil type
- b. Soil cover
- c. Soil color.

Conclusions

The utilization of incoming solar radiation is limited by other factors mainly by water availability either in form of rainfall, underground capillary inflow or irrigation. The effect of the increased solar radiation on maximum LAI values and total above ground biomass is more less the same as on grain yield and reaches the maximum close to the present values of incoming solar radiation even though it seems that slightly lower solar radiation intensity would have an positive effect in the sense of lower yield variability (without sacrificing much of the grain yield

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