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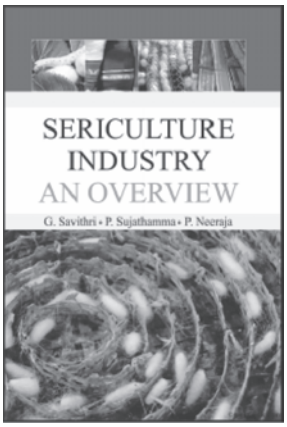

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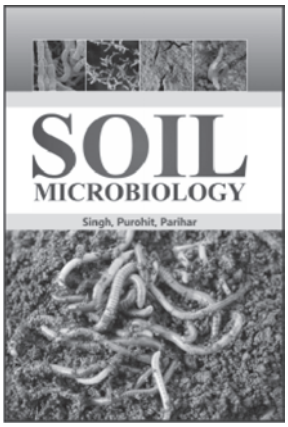

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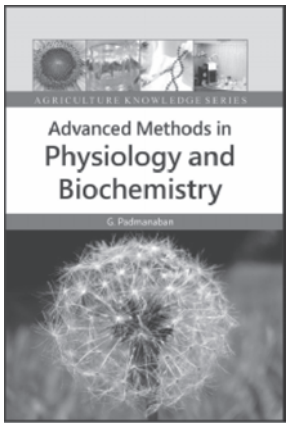

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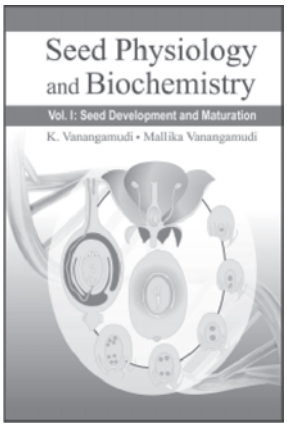

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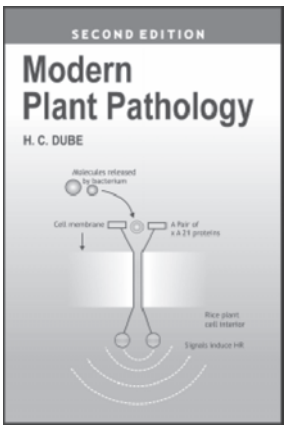

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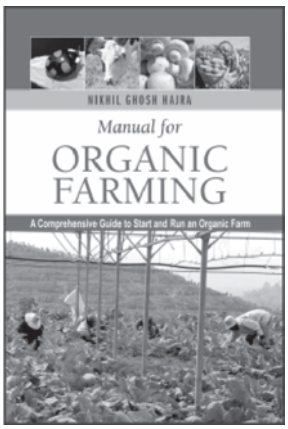

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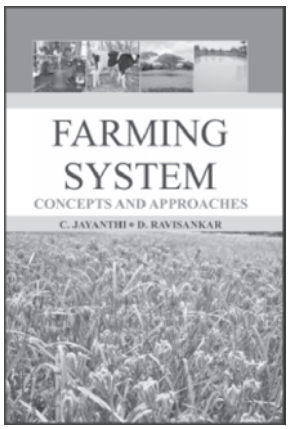

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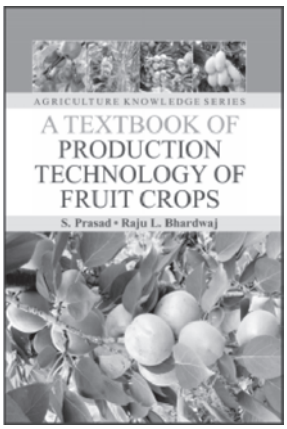

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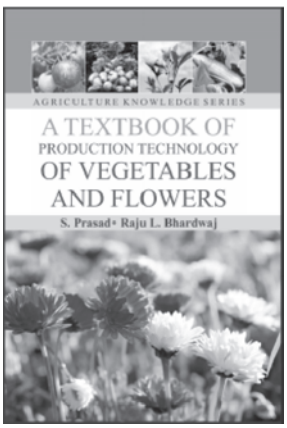

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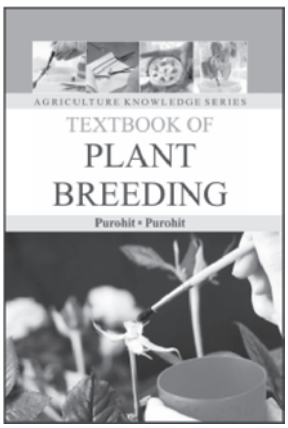

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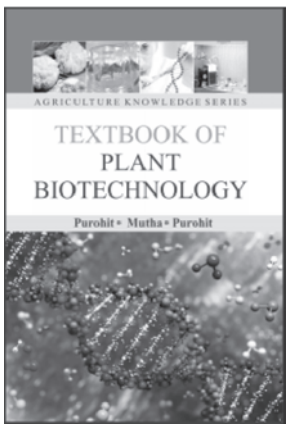

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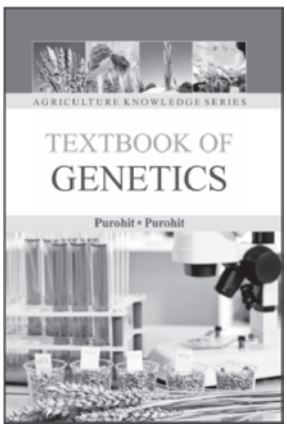

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CONTENTS

AGRONOMY

CROP ECOLOGY AND ENVIRONMENT

CROP PHYSIOLOGY

AGROMETEOROLOGY, REMOTE SENSING AND GIS

WATER MANAGEMENT

ORGANIC FARMING

SOIL SCIENCE

HORTICULTURE

PLANT BREEDING AND GENETICS

PLANT PATHOLOGY

PLANT PROTECTION

NEMATOLOGY

AGROCHEMICALS

ENTOMOLOGY

INTEGRATED INSECT PEST MANAGEMENT

SERICULTURE

SEED SCIENCE AND TECHNOLOGY

EXTENSION EDUCATION AND RURAL DEVELOPMENT

ENGINEERING AND TECHNOLOGY

COMPUTER ADDED TECHNOLOGY

ECONOMICS

AGRONOMY

20236

1. Tree Fodder: An Additive to Fodder Production in India

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Livestock is the key component of Indian agriculture and its production is increasingly viewed as an important risk mitigation strategy for rural households to escape from poverty particularly in the rainfed regions of the country. India has 17 per cent of world cattle population and been the home of major draught, milch and dual-purpose breeds of cattle. Thus, there is a tremendous pressure of livestock on available feed and fodder, as land available for fodder production has been decreasing. The acute shortage of fodder with low quality feeds are major constraints limiting the livestock productivity among small and marginal farmers of the country. As per the 20th livestock census report released by Ministry of Animal Husbandry, Dairying and Fisheries, the total livestock population is 535.78 million in the country which is an increase of 4.6 per cent over livestock census 2012. On the other hand, as per the 10 and 11th five year plan document vision 2030, Government of India the requirement of fodder by 2030 is 1207.1 and 670.6 mt of green and dry fodder but the supply capacity is only 416.7 and 503.4 mt of green and dry fodder respectively which accounts to 65.45 and 24.90 per cent deficit of the demand in the country. In the same line the projected requirement of crude protein and total digestible nutrients including from concentrates by 2030 is 54.37 and 392.7 mt but the availability is 41.20 and 304.11 mt which accounts to 24.22 and 23.32 per cent deficit, respectively. This gap between demand and supply may further increase due to consistent growth of livestock number at the rate of 1.23 per cent in the upcoming years.

On the other hand, cultivated fodder is limited to less than 4.5 per cent of the arable land in the country and the present area under fodder crops is around 8.6 million hectares. But according to National Commission of Agriculture the recommended area under fodder production should be 10 per cent of arable land (16. 5 m ha). However, there is no scope for further increase in the area under fodder crops due to increased competition for cultivable land for growing food grains, oilseeds, pulses and commercial crops and inadequate attention being given to the production of fodder crops in the country along with unscientific management of fodder crops and trees. In this context to meet the fodder needs of increasing livestock population may be possible by increased productivity per unit land area by adoption of better agronomic practices, integration of fodder crops in the existing cropping systems and cultivation of fodder tree species on the bunds, borders and all along the field where space is available as generally 6 to 10 per cent of land area is occupied by bunds.

Since ancient times farmers have used fodder trees and is common in traditional feeding systems. The shoots, tender twigs, stems of woody plants along with their leaves, fruits or pods can be used as a source of feed to livestock. These tree species provide green fodder around the year particularly during lean periods as they are hardy and have ability to sustain under adverse conditions because of their deep root system. Tree leaves are also a rich source of protein with 10 to 30 per cent on dry matter basis thus they can be a potential source to replace concentrates. Besides this some tree species helps to improve the soil fertility by fixing atmospheric nitrogen, addition of leaf litter to soil, arresting nutrient loss through runoff water under high rainfall conditions in addition to providing construction material, fuel wood, shade, shelter and edible pods. Theses fodder trees are easy to grow as they require little land, labour or capital and often supply feed within a year after their planting.

The selection of trees is also important as all the species are not suitable for fodder production. The trees having leaves and pods with high nutritive value, palatability and free from toxins, capacity to produce more number of leaves and quick regrowth after pruning, tolerance to drought, pests and diseases and less competition for resources with crops can be a potential ones for fodder purpose. The tree species like Subabool (*Leucaena leucocephala*), Gliricidia (*Gliricidia sepium*), Ardu (*Alianthus excelsa*), Agasthi (*Sesbania grandiflora*) Shevri (*Sesbania sesban*), Khejri (*Prosopis cinereria*), Mahua (*Bassia latifolia*), Babul (*Acacia nilotica*), Neem (*Azadirachta*

indica), Kachnar (*Bauhinia variegata*), Safed siris (*Albizia procera*), Lallei (*Albizia amara*), Siris (*Albizia lebbeck*), Shisham (*Dalbergia sissoo*), Mulbery (*Morus alba*), Bola (*Morus laevigata*), Drum stick (*Moringa oleifera*), Kikkar (*Prosopis chilensis*), Ber (*Ziziphus mauritiana*) *etc.*, are the potential fodder tree species that can be adopted across the country according to their regional suitability. Thus, introduction of fodder tree species on waste lands, bunds and borders of the field, premises of households, pasture and grazing lands helps to supplement the good quality fodder production in the country.

20244

2. Remodeling the Carbon Footprint of Rice

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Carbon footprint is used to denote the amount of CO_2 produced by our daily activities and use of material goods. Carbon footprint was first suggested by the team of IPCC (Inter governmental Panel on Climate Change) led by Al Gore during the middle of 1990's. Carbon footprint relates to the total greenhouse gas emission produced directly and indirectly by our day-to-day activities. The measurement of carbon footprint is based on carbon dioxide equivalents using Global Warming Potential (GWP). Carbon footprint is a useful tool in identifying the impacts of an activity on climate and it helps to priorities an action to be planned to reduce emissions. Among the "six key well-mixed greenhouse gases" named in the Kyoto Protocol (carbon dioxide, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride) which came into force in 2005, methane and nitrous oxide are emitted by the rice production systems.

Methane from Rice Fields

Methane in the Earth's atmosphere is an important greenhouse gas with an extreme global warming potential. Methane emission will have 23 times the impact as carbon dioxide emission of the same mass in the next 100 years (Minami and Neue, 1994). Methane is a trace gas with approximately 21 times more infrared absorbing capacity per molecule than carbon dioxide (Prather *et al.*, 1996). As per WMO (2009) the globally averaged methane in 2008 was 1797 ppb as against the 700ppb during the pre-industrial 1750. Wetland rice fields are among the important sources of atmospheric methane, with and estimated source strength of 60 ± 40 Tg year-1 (Denier van der Gon *et al.*, 2000). The elevated CO_2 concentrations in flooded soils leads to anaerobic decomposition (methanogenic activity) of organic matter that leads to the formation and emission of various trace gases which are generally not found in well aerated upland soils (Hsu *et al.*, 2009). Among these anaerobically produced trace gases methane is the most prevalent one (Minami and Neue, 1994). Flooded rice fields are a significant source of atmospheric methane. The methanogenic bacteria in the soil utilizes the carbon sources supplied by the plants and other incorporated organic substrates to produce massive amount of methane. Methane is released from anaerobic wet land soils to the atmosphere through diffusion of dissolved methane, ebullition of gas bubbles and via rice plants that develop aerenchyma tissue. Large portions of methane formed in an anaerobic soil remain trapped in the flooded soil. Entrapped methane may be oxidized to carbon dioxide when the flood water is drained during the rice growing season or when the soil dries at the end or after rice growing season. But large amount of entrapped methane may escape to the atmosphere immediately after the flood water recedes (Denier van der Gon *et al*., 1992).

A study was conducted at the Rice Research Station (RRS), Moncompu, during 2001-2002 in collaboration with UNDP-IRRI project on the methane emission from rice fields located in the lateritic soils of Kerala. It revealed that the methane efflux from the lateritic soil of Kerala is generally low. The methane emission from first crop season was ascertained to be 1.64 mg/ m^2 /hr and that of second crop season was 3.50 mg/m^2/ hr. Maximum Methane flux in rice was during the booting stage (Mathew, 2003). Among the various organic sources tested rice straw incorporation resulted in the maximum methane efflux (6.02 mg m^{-2} hr^{-1}) followed by green manuring with glyricidia (4.29 mg m^{-2} hr^{-1}). Farm yard manure recorded the least emission of 2.63 mg m^{-2} hr^{-1}. Factamphos, the complex fertiliser containing ammonium phosphate and sulphur reduced methane emission from the rice fields compared to the most common nitrogen source, urea.

Nitrogen Gases from Rice Fields

Among the greenhouse gases, nitrous oxide (N_2O) is about 310 times more capable of trapping heat than CO_2 on a molecular basis. Nitrogenous fertilisers are the major source for this gas. Nitrous oxide has recorded a mean increase of 0.7 ppb per year over the past 10 years from 1998 to 2007 recording an atmospheric concentration of 321.8 ppb in 2008 (WMO, 2009). Nitrous oxide is produced by natural and human related sources. It is released from oceans, bacteria in soils, nitrogen-based fertilizer, disposing human and animal wastages and automobile exhausts. Human related sources are agricultural soil management, animal manure management, sewage treatment, mobile and stationary combustion of fossil fuels, nitric acid production and by microbial action in tropical forests. The emission of nitrous oxide from agriculture land is from the usage of fertilizer, green manure, animal manure and burning of crop residues (IPCC, 2007)

Mitigation of GHG Emission from Rice Fields

The most effective methane mitigation option would be to prevent submergence of rice fields and to cultivate upland rice. Mid-season drainage or intermittent irrigation which prevent the development of soil reductive condition is considered is an effective option for mitigation of methane from rice fields (Yagi *et al*., 1997) Water is drained out of the field during vegetative period. Drainage reduces methane emission but promote nitrous oxide emissions (Smith and Conen, 2004, Yan *et al*., 2003). Shifting drainage time from vegetative period to reproductive period help reduce methane production and emissions. Avoiding the burning of crop residues is another option to reduce methane emission. Discontinuing of water logging in rice fields during off -season is also an option to reduce methane emission. Timing of organic residue addition, incorporating organic material in the dry period when the soil is moist and not flooded (Xu *et al*., 2000) is another method of mitigating methane emission.

Rice cultivars with lower root exudates significantly reduce methane emission. Reengineering of photosynthesis in rice can be possible by improving the CO_2 assimilation based on C4 mechanism. By optimizing the rice production to maximum rice yield, methane emission can be curtailed. Methane emission decreases when grain yield increases (Hsu *et al*., 2009).

The fluxes of nitrous oxide into the atmosphere can be reduced by managing more efficiently the flows of nitrogen in the agricultural ecosystems. Shorter drainage period helps to reduce both methane and nitrous oxide emission. The practice that deliver added N more efficiently to crop often suppress the emission of nitrous oxide (Bouman, 2001). Adjusting the rates of N application based on precise estimation of crop needs *e.g*. precision farming. Use of slow release fertilizer or nitrification inhibitors controls methane emission. Avoiding the time delay between N application and plant nitrogen uptake and avoiding of excess N application and eliminating N application wherever possible are other factors effecting nitrous oxide mitigation.

Conclusion

Carbon footprint is an internationally accepted yard stick to measure the impact of different production systems and consumption systems on climate change. Rice based cropping system especially the wet land systems emits methane. Shortening the drainage period and multiple drainage can mitigate the emissions of Methane and Nitrous oxide. Scientific management of crop residues and organic manures is another vital factor for minimizing the greenhouse gas emission. Aerobic rice cultivation rather than flooded rice cultivation is another alternative for controlling the emissions. Management tactics like providing training and creating awareness among the cultivators about greenhouse Gas emissions from rice field and its impact on climate change is also a crucial factor to control the emission of these gases into the atmosphere.

20260

3. Instrumentation Used in Scheduling Irrigation

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Introduction

An ideal irrigation schedule indicates when irrigation water is to be applied and the quantity of water to be applied. Several approaches for

scheduling of irrigation have been used by scientists and farmers throughout the world, each one with its own advantages and dis-advantages. There are different approaches for scheduling of irrigation *i.e.* Critical stage approach, Soil moisture depletion approach, Can evaporimeter approach, IW/CPE approach etc. Some other methods that boosts the scheduling now a days are *i.e.* dendrometry method, fruit gauges, tissue water content, stomatal conductance, flow sensors, thermal sensing, porometer, plant stress tracking etc. *Irrigation* is the artificial means of water supply to plant root as per to fulfill the optimum water requirement by plant to survive and to secure maximum growth and yield.

$$IR = WR - (ER + S)$$

Where, IR = Irrigation requirement, WR = Water requirement, ER = Effective Rainfall, **S** = Soil profile moisture contribution

Soil Moisture Depletion Approach

Irrigation is provided to replenish the depleted soil moisture from root zone depth. This depletion level is different for different crops.

- For maize and wheat, it is 25% depletion of available soil moisture.
- For cotton, sorghum, bajra it is 50% of depletion of available soil moisture.
- For most crop yield advantage in 50% of depletion of available soil moisture.

This approach is reliable but cannot be recommended to farmers because to measure soil water content is not easily available. He can only estimate approximately by feel and appearance method.

IW/CPE Ratio

This approach is suggested by Parihar *et al.* Irrigation is given at predetermined level of cumulative pan evaporation (CPE) value. The amount of water given at each irrigation ranges from 4-6 cm, most commonly being 5cm. Ex: 5cm irrigation is scheduled at an IW/CPE ratio 1.0 that indicates 5cm of irrigation water is supplied when cumulative pan evaporation reaches 5cm.

Can Evaporimeter Approach

Small cans of 1litre capacity with can size of 14.3 cm height and 10 cm diameters are used to indicate evaporation from the crop field. The can should be covered with 6/20 mesh and should be painted white. Below the beam, at 1.5cm an indicator is attached. The can should be filled when the irrigation is given up to field capacity and the can should kept at crop height. Evaporation from can directly related to crop ET. Irrigation scheduled when the water level in the can falls to a predetermined level (equal to the amount of water to be applied at each irrigation) and can is filled again to pointer level.

Critical Stage Approach

This is the mostly followed and accepted approach by farmers. Critical stage of moisture is the stage where if there is deficit in irrigation/moisture level in root zone the maximum yield reduction occurs. In cereals, panicle initiation and flowering and in pulses, flowering and pod development stages are most important moisture sensitive stages.

TABLE: Moisture sensitive stages of important crop

Crop	Important moisture sensitive stages
Rice	Panicle Initiation, Flowering
Wheat	CRI, Jointing, Milking
Sorghum	Seedling, Flowering
Maize	Silking, Tasseling
Groundnut	Flowering, Pegging, Early pod formation
Red gram/Green gram/Black gram	Pre flowering, Pod formation
Sugarcane	Formative, Grand growth

Simple Techniques for Irrigation Scheduling

Soil cum sand mini-plot technique

$1m^3$ pit dug in middle of the field. 5% sand mixed with the dugout soil and refilled to the pit. Crop grown as usual in entire area including the pit area. The plant in pit region show wilting symptom earlier than other and irrigation scheduled soon as wilting symptom appear on the plants in pit area.

Sowing high seed rate

In an elevated area, $1m^2$ area selected and crop is grown with 4times thicker than normal seed rate. Plant transpire and use the available soil water at faster rate and show wilting symptoms earlier at densely planted area and considered as the time for scheduling the irrigation.

Feel and appearance method

Moisture level can roughly estimate from root zone into the hand and making ball. It requires much more experience for approximation.

Plant indices

Any plant character related to deficit of moisture like wilting of leaves can be considered as scheduling of irrigation but this is not so accurate that wilting symptom that may be for other region like pathogen attack or nutritional disorder etc.

Irrometer/ tensiometer approach

This is based on soil moisture tension. Tensiometer are installed at specified depth in the root zone. When moisture tension in soil reaches specified

value 0.5/0.75 irrigation is given. Generally used for irrigation in orchards especially in coarse textured soil. It doesn't give information on amount of irrigation water to be applied and can work up to 0.85 bars.

Sophisticated techniques for irrigation scheduling

Growth indicators like cell elongation rate, plant water content, leaf water potential, plant temperature, leaf diffusion resistance etc. are also used in research programs for deciding the irrigation scheduling. But all these methods required intensive research, expensive equipment and standardization.

Infrared thermometry

Canopy temperature is measured with infrared thermometer. It also simultaneously measures canopy temperature (T_c) and air temperature (T_a) and also displays T_c-T_a value. This value can be used for scheduling irrigation. Transpiration generally cools the crop canopy and during transpiration the air temperature is more than the canopy temperature. The - ve value of T_c-T_a value that the plant have sufficient amount of water. When this value is zero or +ve, indicate stress and irrigation is scheduled. Stress degree days (SDD), useful for irrigation scheduling are summed in a manner that is analogous to growing degree days.

$$SDD = \sum (T_c - T_a)$$

Canopy temperature is measured during mid-day when air temperature is maximum. Yield reduction is maximum when the total number of cumulative SDD exceeds 10-15 between irrigation.

Remote sensing

In project area, where a single crop is grown on a large area, irrigation scheduling can be done with the help of remote sensing data. The solar radiation reflectance is different for well-watered and water stressed plants. This principle can be used for scheduling of irrigation.

Conclusion

Irrigation scheduling is an important criterion to successfully manage the irrigation water and increase the crop yield. There are several conceptual methods which are used in scheduling of irrigation *i.e.* trunk diameter observation, deficit scheduling for increasing the crop hardiness towards water stress etc. are added to the existing methods. There are different plant and soil-based scheduling methods which have their own advantages and disadvantages. Farmers prefer irrigation scheduling *i.e.* feel and appearance of soil for moisture and scheduling according to growth stage but the methods those can be recommended to farmers for scheduling irrigation; Soil-cum-sand mini plot technique, Increased plant population and Can evaporimeter.

References

Jones, H.G. 2004. Irrigation scheduling: advantages and pitfalls of plant-based methods, Journal of Experimental Botany, 55 (407), Pp: 2427–2436.

Reddy, S.R. 2014. Introduction to Agronomy and Principles of crop Production, Kalyani publisher.

Reddy, T.Y., Reddy, G.H. 2010. Principles of Agronomy, Kalyani Publisher

20297

4. Social Distancing in Crops!

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Social distancing, today's buzz word in this COVID-19 pandemic, communities are being asked to reduce close contact between people, this is called social distancing. It's the foremost and effective way to slow down the spread of this virus. It is also called "physical distancing," which means keeping distance with other people outside of your home. It is one of the efficacious steps to avoid being exposed to this virus and slowing its spread locally and across the country and world. Similarly, social distancing in crops also has immense importance. Social distancing in plants scientifically called spacing. Crop spacing is the number of crops planted per unit area. Here we are considering the space between one plant and another. Many scientists are advised to follow the proper spacing according to their research findings for improving the crop yield.

It's very important to provide proper spacing between the crops as it affects the yield of a particular crop and it reduces the risk of disease spreading. There will not be much competition among the plants for light and nutrients, roots can spread as much and they can absorb enough nutrients from the soil. Closer spacing reduces the air circulation and which will lead to faster spreading of diseases

and it may provide a good ambiance for the growth and development of various pests. There are many diseases like blight, rot, and mildew which will harm the crop if sufficient moisture is available in between the vegetation.

To sustain the productivity and better yield farmers are exploiting their land by intensified cropping without caring proper spacing. Many farmers plant closer together than recommended when using raised beds. Now, there is some truth in this and you could get away with planting most things leaving half the amount of space as you normally would, but we would always recommend that you stick to the planting advice unless you are an experienced farmer. There are scientifically recommended spacing for different annual crops, crops should be well spaced to achieve the best results

Space Recommendation of some Important Crops

Crops	Spacing
Rice	
Short duration	15 x 10 cm
Medium Duration	20 x 15 cm
Maize	60 x 25 cm
Groundnut	15 x 15 cm
Pepper	3 x 3 m
Arecanut	2.7 x 2.7 m
Tobacco	85 x 85 cm
Tomato	60 x 60 cm
Cauliflower	60 x 45 cm
Banana	2 x 2 m
Papaya	2 x 2 m

It is always necessary to follow the recommended crop spacing guidelines provided. Due to overcrowding, competition among the crops for sufficient inputs will be maximum. It may reduce yields and it may also lower the quality of the crops produced. Improper spacing will make difficulty in intercultural operations as it may be hard for the farmer to walk about in the garden weeding, spraying pesticides, or doing crop inspection. Spacing is very important in the case of intercropping. If, for example, Wheat is to be intercropped with mustard, it is good to have wider space between wheat plants so that the mustard will get sufficient light and nutrients to grow well. There are different methods sowing, including dibbling, line sowing through these methods farmers can achieve proper spacing. Instead of these farmers are following the broadcasting of seeds for some crops such as millet and some vegetables to avoid labor cost. Along with proper spacing, the thinning operation also very important to maintain a uniform population of the crops. To ease such activities as weeding, harvesting, spraying, and general crop inspection, the farmer is best advised to follow the recommended spacing.

Advantages of Crop Spacing

Crop spacing influences at various stages and different aspects of crop growth including nutrient uptake, intercultural operations, disease management, crop harvest, and the final yield.

Nutrient uptake

All the plants required essential nutrients for the growth and development, Plants absorb nutrients from the soil and we can improve soil fertility by the applications of nutrients as manures and fertilizers. Plants have to compete with their neighbors for soil nutrients and sunlight along with that their roots will have to compete not only for nutrients and water but also for space. Through better spacing, we can avoid this completion through which crop yield can be improved.

Disease Management

Proper spacing reduces the risk of disease in two ways: contagion and improved immune system. Spreading of the disease will be easy from one plant to another if the plants are growing close to one another, so plants growing too closely are not as healthy as compared to plants with enough space.

Intercultural Operation

It is easy to carry out intercultural operations like weeding and earthling up if plants are sown with sufficient spacing between plants and rows. Weed management is one of the most important steps to promote healthy plants. It is difficult weeding when plants are too closed, which will lead to more weed growth.

Ease of Harvest and Increased Yield

Harvesting will be less difficult if plants are grown with proper spacing as recommended and farmers can easily calculate the yield from a particular area. Researchers reported that plants grown with proper spacing will produce more yield as compared to plants grown unscientific planting process.

It can be concluded that spacing has a tremendous influence on different aspects of crop growth and yield, which will help for nutrient management, to carry out intercultural operations and harvesting of the crop.

20324

5. Kala Bhat: An Unmatched Paramount of Nutritional and Medicinal Properties

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Introduction

Black-seeded soybean (*Glycine max* L. Merril), locally known as Kala bhat is grown as an important kharif crop in the hilly areas of Uttarakhand and in the bordering states of Himalayan range. The commercially grown yellow seeded variety of soybean is genetically improved and popular throughout the world for the soya oil. Black soybean has gained noticeable popularity in last few years apparently due to its exceptional nutritious and medicinal properties that are lacking in yellow ones. It is officially listed in the Chinese pharmacopoeia (2015 edition) as a medicine but still this is an ignored food crop. Despite of the fact that black soybean has immense potential; the production area for this valuable crop is confined to North Himalayan hilly region of India. Its prodigious nutritive values and therapeutic effects due to presence of various bioactive compounds can make this legume a super food.

Botanical Description

Black seeded soybean is a short duration annual leguminous crop with 3-4 months life span depending upon genotype and environmental conditions. The traditional cultivars of black soybean generally have spreading growth habit, long maturity duration, very low yields and freely shattering pods. The root system is primarily consisting of tap root with several fibrous roots, colonized with a nitrogen-fixing nodule bacteria *Bradyrhizobium japonicum* (genus *Rhizobium*) which accomplish the nitrogen requirement of the plant through symbiotic N_2 fixation. It has a typical papilionaceous flower of white or purple colour. The fruit is a hairy pod that grows in clusters, straight or slightly curved in shape, about 1 cm in width and 3–7 cm in length and colour of pods depending upon different cultivars. Matured seeds of black soybeans with characteristic black seed coat are varied in morphology and grouped as, large black seeds, flat black seeds and small black seeds.

Nutrition

Black soybean is incredibly rich in nutritional content and comprises high protein (32.1–39.8%), carbohydrate (30%), dietary fibre (21.77–30.31%), fat (10.8–19.6%) and minerals (3.93–6.15%). The 1/2 cup (130g) of soybean contain Protein (11gm), calories (120 kcal), Fat (6gm), Carbohydrate (8 gm), Sodium (30mg), Fibre (7 gm), Sugars (1gm) (USDA). Black soybean grains are also good source of thiamine, riboflavin, niacinand tocopherols. This is the only legume which contains all nine essential amino acids. The combination of potassium and high sodium is rarely available in any single food source but in grains of black soybean, hence favourable for low blood pressure patients.

The Black soy milk contain appreciable amount of protein, carbohydrate and minerals but fat content is negligible, this make it as a potential food supplement for athletes and for diabetic people.

Medicinal Properties

Black soybean seeds have miraculous medicinal properties primarily due to presence of various bioactive compounds like; phenols, isoflavones, saponins, flavonoids, anthosinin and phytosterols contained in most parts of the seed but especially in the seed coat. The antioxidant and antiaging properties possessed by black soybeans is mainly due isoflavons. Genistein and daidzein are most abundantly found isoflavons in these seeds and have antioxidant, anti-inflammatory, anti-viral, and anti-microbial activity, also act as a phytoalexin, *i.e.* the compounds produced by plants in response to pathogen attack. The oil of Bhat contains linolenic acid and it is cholesterol-free which has been found to prevent heart diseases.

Black soybeans are used to relieve kidney diseases, to increases blood circulation, to control cholesterol level, to inhibit growth of cancerous cells, to treat diseases like jaundice, lockjaw,

beriberi, etc. In the villages of Uttarakhand hills the food made of black soybean viz; 'Bhatiya', 'Bhat ki sabji' is given to the patients of jaundice. Interestingly it was found that the people of Japan, consuming black soybean are less affected by pollution and adverse effects of radiation. For weight loss also black soybeans are considered as superior food as contains more protein and antioxidants and less carbohydrates than other beans. Because of the incredible health benefits served by black soybean, it is advised in some hospitals of Uttarakhand to include 'bhatt ki dal' in patient menu of food.

Conventionally black soybean is consumed in the hills after processing, this include soaking the grains overnight followed by boiling (Shah 2006). This process meliorates the nutritive values and reduces the 'antinutritional factors' of soybean.

Antinutritional Factors

Several antinutritional factors (ANFs) are also present in the black soybean seeds that reduce the bioavailability of some nutrients. Lectins and Kunitz trypsin inhibitor (KTI) are considered as the major ANFs in black soybean grains. This antinutitional factor reduces the digestibility of soy protein and causing digestion related diseases in animals. However, several processing methods like sprouting, roasting, boiling and cooking can reduce these antinutrients and impart positive effects on nutritional quality.

Conclusion

The awareness about the potential health benefits of antioxidants for human health is growing worldwide and it encourages the researchers and scientists to find the source of antioxidants. The abundance of numerous nutritional and therapeutic bioactive compounds makes the black soybean a wholesome food to be added in daily meals as supplement to cereal based diet. The medicinal significance of this legume is well documented but even after it failed to notice, the medicinal bioactive compounds present in these seeds has not yet used as drug to cure the diseases. To comprehend its real potential and for its wider utilization extensive research is needed and it must popularize in health care world.

References

Alghamdi, S., Migdadi, H., Khan, M., El-Harty, E. H., Ammar, M., Farooq, M. & Afzal, M. (2018). Phytochemical Profiling of Soybean (Glycine max (L.) Merr.) genotypes Using GC-MS Analysis. In *Phytochemicals - Source of Antioxidants and Role in Disease Prevention*. InTech.139:159.

China. Pharmacopeia of the People's Republic of China. Beijing: China Medical Science Press; 2015. 344 p.

Dakora, F.D. and Phillips, D.A. 1996. Diverse functions of Isoflavonoids in legumes transcend ant-microbial definitions of phytoalexins. Physiological and Molecular Plant Pathology 49: 1-20.

Sumardi, D., Pancoro, A., Yulia, E., Musfiroh, I., Prasetiyono, J., Karuniawan, A. and Syamsudin, T.S. (2017). Potential of local black soybean as a source of the isoflavones daidzein and genistein. International Food Research Journal. 24(5): 2140–2145.

Gupta, R. (2017). Soybean seed: A treasure trove of bioactive compounds. Journal of Microbiology and Biotechnology Reports. 1(1): 5.

Patel, K. D. & Pandya, A. V. 2014. Assessment and biochemical analysis of black soybean (with and without seed coat). World Journal of Pharmaceutical Research. 3(3): 4272-4278.

Shah, N.C. 2006. Black soybean: An ignored nutritious and medicinal food crop from the kumaon region of India. Asian Agri-History. *10*, 33–42.

Xu B, Chang SKC. 2008. Antioxidant Capacity of Seed Coat, Dehulled Bean, and Whole Black Soybeans in Relation to Their Distributions of Total Phenolics, Phenolic Acids, Anthocyanins, and Isoflavones. Journol of Agriculture and Food Chemistry. 56(18): 8365-73.

Zhou, R., Cai, W. & Xu, B. (2017). Phytochemical profiles of black and yellow soybeans as affected by roasting. International Journal of Food Properties, 20(12): 3179–3190.

20325

6. Vertical Farming: Is a Future of Farming

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Day by day increasing population puts stress on the global agriculture sector. Nearly 10 billion population may reach by 2050, so 70 % of food production must be increased said by the United

Nations. However, the peoples are looking to increasing agriculture land by deforestation but it is not a good method to increase food production; it leads to cause global warming. Present situation the forest areas are lesser than the requirement. Increasing day by day building, factories other infrastructure useful lands reduces agriculture production. Due to shrinkage of water, deeper underground water, poor quality water leads to reduces crop yield. Increasing soil degradation forming gullies ravines, saline, acidic and sodic soils are supporting to reduce crop yield. Due to the incidence of pests and diseases and low nutrition quality of food decreases farmer's income. Old farming practices push peoples to other sectors it creates scarcity of laborers in agriculture sectors and another way creates unemployment problems.

There is a need for technological innovation needs to overcome these problems. Vertical farming is one of the technologies that follow the principles of sustainable development and utilizes resources efficiently under the present situation. "Vertical farming is a farming practice, growing of crops in vertical positions under controlled environmental conditions". It can be grown in a non-tropical region where arable land is not available and it is more efficient than land-based farming. And it involves hydroponics saves around 70 % of water than the normal method.

Working Principles

There are four main principles they are, 1. Physical layout, 2. Lighting, 3. Growing medium and 4. Sustainability features.

Initially, the primary aim is to the growth of more suitable crops in a lesser area. Growing of crops in vertical direction likewise stacked layers of the tower structure. Secondly, light penetration into the structure by lighter from the natural or artificial light supply. Increasing this light efficiency to adopt the technology by making the rotating bed structure helps equally distributing light. Next, instead of soil as a medium, adopt hydroponics, aeroponics, and aquaponics as bedding medium. Cocopeat or coconut husk are other common medium used in vertical farming. Crops absorb more vitamins and minerals from soil-less cultivation farming than land-based farming and grow vigorously. By using this vertical farming, we can save 95 % of water.

Types of Vertical Farming

It comes in different shapes and sizes based on area availability two-lined or wall-mounted and large stored structure. But the all vertical farms need to supply the nutrients to crops adopt any one method of the soil-free system; they are hydroponics, aeroponics, and aquaponics (Fig.1).

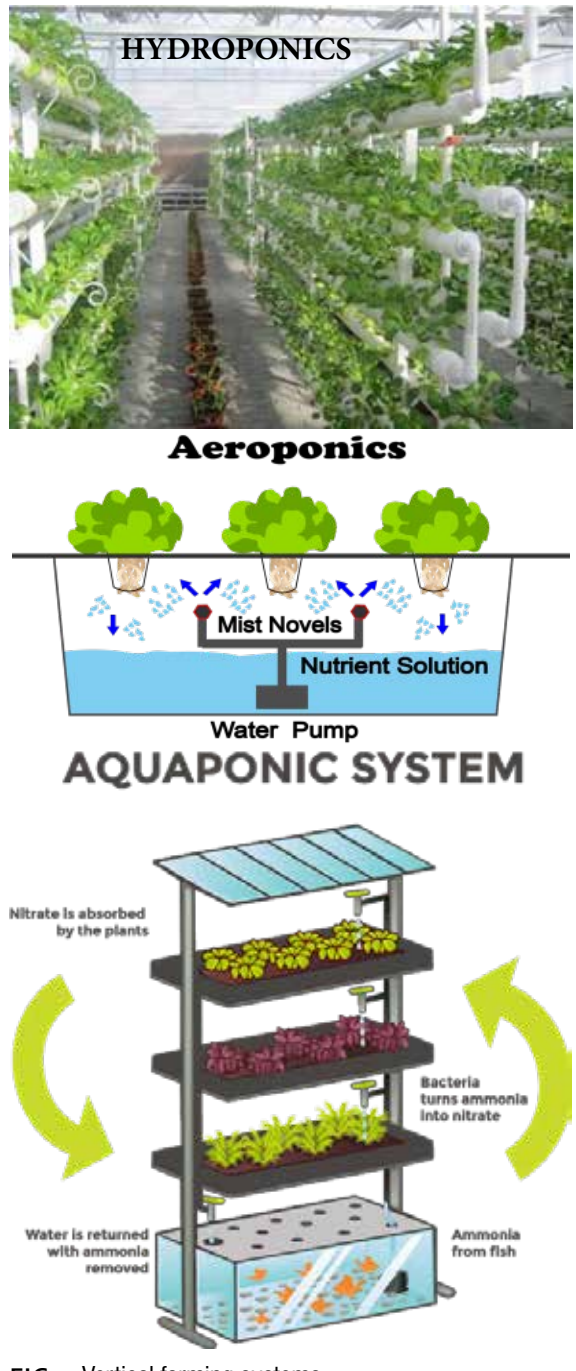

FIG.1: Vertical farming systems

1. **Hydroponics:** it is the most common type used in vertical farming; it involves the supply of nutrients without a soil medium. The continuous movement of nutrient solution in this system to maintain the continuous supply of chemical to crops for more time.
2. **Aeroponics:** it is growing of crops in the soil-less medium by using environment mist and very less water. Initially, this technology was developed by the National aeronautical space

agency (NASA), in 1990's NASA interested in finding efficient crop growing method in spaces and coined the term aeroponics. It saves the highest water around 90 % and vitamins and mineral-rich crops produced.

3. **Aquaponics:** it is the next step to hydroponics, growing plants, and fishes both in the pond. The fish waste material can be used as nutrients to crops and plants gives clean water medium to fishes to grow well.

Suitable Crops in Vertical Farming

Based on the shape, size, and requirement of crop environment crops can select. The most common crops are vegetables and medicinal plants. They are lettuce, basil, kales, chard and collard greens, mint cinnamon, and lemon. And some woody herbs like rosemary, thyme, and oregano these should be short life cycle.

Advantages

Vertical farming is a different approach toward agriculture which has several advantages way to future agriculture. They are as follows.

1. Many farmers don't have arable lands for cultivation it is the best solution for indoor farming
2. It consumes less area the farmers want ore crops in the lesser area so it is the best and is producing in 1-acre land which is equal to 4-5 acres of land area
3. It requires less water so the farmers need not worry about crop failure due to insufficient rain
4. Less chance of crop failure due to crops are grown under controlled environmental conditions, crop requirement environmental conditions can be supplied through artificially.
5. More nutrient-rich crops supplied
6. It reduces the transportation cost by building it in cities or nearby cities that supply fresh and healthy food.

Disadvantages

1. High investment for making infrastructures like land, building, bedding medium, and light adjustment
2. Temperature regulation, artificial lighting, and water pumping adds more cost to the cultivation
3. All crops are not suitable mainly vegetables and fruits are preferable and giving more preference to fast-growing crops
4. Pollination problem because of the growing of crops in controlled environmental conditions avoids the entry of insects for collecting nectar, so hand pollination is to be done.
5. It creates unemployment because of no need of transportation and cultivation practices can be operated by machines with using less skilled labors.
6. Electricity- if it stops one-day chances of all the crops may die, mainly it is used for pumping nutrient water temperature maintenance.

20340

7. Aerobic Rice: A Water Saving Approach for Rice Cultivation

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Rice belongs to the family Poaceae, one of the important cereal crop and staple food of about 60 per cent of the world's population and based on the evidence, rice crop was known to be domesticated in 'Yangtze rice valley' region of China about 8000 years ago. In Asia, quite 50% of all water used for irrigation is for rice. Irrigated rice accounts for about 55% of total area and 75% of total production of rice all over the world. By the end of 2025, about 13 mha of irrigated wetland rice and 2 mha of irrigated dry season rice could suffer from 'physical scarcity' of water in Asia and in South and southeast rice area region, approximately 22 ha of irrigated dry season rice may experience 'economic water scarcity'. Therefore, many efforts are underway by researchers to develop such technologies like Alternate wetting and dry, irrigation at an interval of 1 to 5 days and at soil moisture tension of 0 - 40 kPa, grown in non- puddled, well drained and non-saturated soils. Such water saving technologies are known as aerobic rice systems (ARS).

Aerobic rice is one of the technologies in which the water requirement can be lowered by reducing the losses such as percolation, evaporation and seepage losses. Therefore, it is grown like an improved upland rice and lowland rice in terms of yield potential and drought tolerance respectively and it increases the WUE in rice crop. Farooq *et al.* (2009) reported that under such water conditions with moderate application of fertilizers, aerobic

rice can produce about 4 – 6 t/ha yield which is 20 to 30 % lesser compared to transplanted rice and about 2 or 3 times compared to traditional rice varieties. Thus, aerobic rice saves more than 50 per cent water as compared to transplanted puddled rice.

Water Saving Techniques

Rice needs about 1700-3000 litres of water to produce 1 kg rice depending upon availability of water, soil and climatic factors such as rate of percolation, hydraulic conductivity, temperature, rainfall, wind velocity, humidity etc. Water issue is the major problem in the coming future as ground water level is depleting due to excessive use of water in the production of rice. However, day by day water is getting scarce and about 50 to 55 % of total water in the world will be there for use in agriculture as compared with 66 to 68 % in 1993. Some of the water saving techniques are discussed below:

Shallow Submergence of Water in Rice

Generally, rice crop is irrigated with a standing water of 10-15 cm column or more. However, 3–10 cm submergence was sufficient for obtaining rice yield and control of weeds. Weed growth is restricted in case of submergence of water. Also, loss of yield is lesser in case of transplanted puddled rice due to suppression effect of standing water on germination and growth of weeds. Further, the efficiency of some herbicides also improves due to standing water. The other benefits of shallow submergence include regulation of soil temperature (important in severely cold and hot regions), dissipation of excess solar energy and development of favourable microclimate and favourable growth of blue green algae.

Alternate Wetting and Drying (AWD)/ Partial Aerobic Rice Systems (ARS)

Numerous studies are being conducted at All India Coordinated Research Project on Water Management (AICRPWM) research stations and reported that providing irrigation at field capacity or 2 – 3 days after disappearance of flooded water give better yield as compared to continuous submergence therefore net saving of about 40–54% in irrigation water. Sharma, (1999) reported that through shallow submergence of rice, yield obtained was 71-102 % while in case of intermittent submergence, it was 86-105 %.

Conservation Technologies

Direct seeded rice (DSR) is one of the water saving technology as an alternate to transplanted rice as DSR require less labour and generally it gave around 75 per cent of grain yield as obtained in transplanted rice but the reduction in irrigation water demand was 50 % as obtained in TPR. Another technology which can be used for resource conservation such as laser land levelling, it makes the surface of soil to become smooth that results in saving of water, nutrients and enhances the crop yield and better environmental quality.

Conclusion

Overall aerobic rice technology may be a promising technology which will fire up another green revolution by increasing productivity of rice using less water and fewer inputs like less seed rate, less labour, less greenhouse gases (methane) emission and efficient fertilizer utilization. Aerobic rice varieties should be selected having desired characters such as grown under less water conditions with less emission of greenhouse gases (GHG) thereby help in combating future climate change. However, a lot of research has to be carried out in developing high yielding aerobic rice varieties to address economic water scarcity and safety of environment arising due to global climatic change for sustainable ecosystem.

References

Farooq, M., Kobayashi, N., Wahid, A., Ito, O., and Basar, S.M.A. 2009. Strategies for producing more rice with less water. *Advances in Agronomy* **101:** 351–388.

Sharma, S. N. 1999. Water Management. In "A Text Book of Rice Agronomy" (R. Prasad, Ed.), pp. 131–144. Jain Brothers, New Delhi.

CROP ECOLOGY AND ENVIRONMENT

20341

8. Role of Wetlands in Agriculture

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Wetlands are the distinct ecosystem in which the water table is at, near or just above the surface of the earth, where soils are saturated for either permanently or seasonally. These landforms are located in between terrestrial systems and permanent water bodies like rivers, lakes, or oceans and these are factors that differentiate wetlands from the other forms of land. Approximately 6 % of the world's area is occupied by wetlands whereas in India about 4.1 million hectares are covered by wetlands in different categories according to a survey carried out by the Ministry of Environment and Forests in 1990. Since soils are saturated, it forms unique hydric soil results in low soil oxygen levels and also rich in nutrients. Wetlands are classified as freshwater, saltwater, and manmade wetland (also called a constructed wetland). Wetlands are summarized into hydrological, chemical, biological, and socio-economic functions. Hydrological functions are major in preventing flood, soil erosion and also include recharge of aquifer present in the wetland. Wetlands act as natural filters in wastewater treatment for removing chemicals especially nutrients. This ecosystem has unique biodiversity which leads habitation for flora and fauna. Production of drinking water, agriculture production, firewood, fisheries, etc. are included in socio-economic functions.

Wetlands act as an open system in which receives inputs from other ecosystems and also from solar energy which produces output in the form of agriculture produce, habitation, improving water quality. The unique hydric characteristic of this soil provides rich nutrients and organic matter hence the productivity also increased. However, the soil is hydric, a special method for cultivation practices is adopted based on the locality.

Wetlands that can contribute to agriculture in such a way that it supports fertile soils, reduce erosion, and retain sediments and nutrients as well as reduce the potential for salinity and acid sulphate soils. It also benefits for aquaculture or grazing, provides habitat for animal species, provides drinking water for livestock, protection from floods, provides a wide range of raw products such as timber, stock fodder, firewood, and also assists in drought resilience.

Wetland agriculture has been carried out in several methods, it can be crop fields and river flood plain soils as major examples. Due to nutrient-rich soils and natural fertility, flood plains in river basins are adopted in many parts of the world and these areas have been highly suitable for agriculture. The flood plain sediments are regularly deposited by flooding with river water in very wide, flat areas from natural levees. The lower parts of flood plains are often suitable for grazing because of wet conditions, whereas higher parts of flood plains are most suitable for cultivation practices. Moreover, intensive agricultural use in wetlands is a serious problem because of the oxidation and subsidence soil especially in peat soil which finally consequences to more carbon dioxide emissions. In some parts of South-East Asia, development happening where vast areas are being converted into agricultural fields. Extensive use of wetlands without reclamation measures might result in an imbalance of ecosystem imbalance biodiversity, remaining more or less intact. There is a need for research by agriculture scientists and environmental scientists to optimize such solutions.

Wetlands are considered as dynamic ecosystems in nature because the natural fluctuations are part of the system. Due to human activities, it may risk the ecological character of the wetlands that will be altered to that point.

Conclusion

Wetlands serve an important resource for agriculture in fulfilling nutrients, water, and fertile soil. Even though the adoption of new technologies by farmers or the reintroduction of traditional practices with new technological support, agricultural activities which can disturb wetland functions and ecosystem. However, climate, wetlands, agriculture, and communities vary so greatly from region to region, experience, and observations from many wetlands show that

it is indeed possible to find mutual benefits for agriculture and wetlands, particularly when local solutions are implemented using local knowledge, within larger integrated planning efforts.

CROP PHYSIOLOGY

20265

9. Molecular Biology of Abiotic Stress

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Introduction

Plants are exposed to several adverse environmental conditions that potentially generate stress and affect negatively on their growth and productivity. It is essential to minimizing the deleterious impacts of stress and maximizing productivity. In order to overcome these threats of biotic stresses plants have developed various mechanisms. Plant sense the external stress environment, get accelerated and then generate appropriate cellular responses (Rodríguez M. *et al.* 2005). They do this by stimuli received from the sensors located on the cell surface or cytoplasm and transferred to the transcriptional machinery situated in the nucleus, with the help of various signal transduction pathways. This makes differential transcriptional changes in the plant tolerant against the stress. The signalling pathways act as a connecting link between them and play important role between sensing the stress environment and generating an appropriate physiological and biochemical response. The defence mechanisms which act against these stresses are controlled genetically by plant's genetic code stored in them. The biotic stress is different from abiotic stress, which imposed on plants by non-living factors such as sunlight, temperature, cold, drought and floods having negative impact on crop plants. Its climate in which the crop lives that decides what type of biotic stress may be imposed on crop.

A plants first line of defence against abiotic stress is in its roots. The chances of surviving stressful conditions will be high if the soil holding the plant is healthy and biologically diverse. One of the primary responses to abiotic stress such as high salinity is the disruption of the Na+ /K+ ratio in the cytoplasm of the plant cell. The phytohormone abscisic acid (ABA) plays an important role during plant adaptation to environmental stress such as high salinity, drought, low temperature or mechanical wounding (Larkindale, J. *et al.*. 2005). These abiotic stresses are interconnected with each other and may occur in form of osmotic stress, malfunction of ion distribution and plant cell homeostasis. So, the identification of responsive genes against abiotic stresses is necessary in order to understand the abiotic stress response mechanisms in crop plants (Cushman, J.C. *et al.*, 2000).

The abiotic stresses occurring in plants includes

Cold

One of the main abiotic stress, affect their post-harvest life, by chilling and freezing conditions that are very harmful to plants as stress.

Salt

Two primary effects are imposed on crop plants by salt stress; osmotic stress and ion toxicity. The osmotic pressure under salinity stress in the soil solution exceeds the osmotic pressure in plant cells due to the presence of more salt, and thus, limits the ability of plants to take up water and minerals like K+ and Ca2+. These primary effects of salinity stress cause some secondary effects like assimilate production, reduced cell expansion and membrane function as well as decreased cytosolic metabolism

Drought

Drought lead to death of plants prematurely, Plants reduce their growth of shoots under drought conditions and reduce their metabolic demands. After that protective compounds are synthesized by plants under drought by mobilizing metabolites required for their osmotic adjustment. In recent years, losses related to drought have been the main challenge for grain production. Due to decreased leaf size and production, and higher rates of leaf senescence) reduced stomatal conductance. In

addition to factors leading to a lower transpiration rate, the adaptation to water deficit involves a greater capacity for water absorption by the plant.

Heat

When plants encounter heat stress the percentage of seed germination, photosynthetic efficiency and yield declines. Under heat stress, during the reproductive growth period, the function of tapetal cells is lost, and the anther is dysplastic. Polyamines are low molecular weight aliphatic nitrogen compounds positively charged at physiological pH.

Conclusions

The molecular biology study of plant provides better understanding of the signal-transduction cascades during abiotic stress. Osmatic stress predominantly affects the growth and development, but in species that have a high rate of salt uptake or which cannot compartmentalize salt in vacuoles or impose an additional stress on plant. This mechanism categories them into salt sensitive and salt tolerant plant. So, this implies that any improvement in any stress resistance would make a plant more adaptable. Hence it is important to study molecular level biology for abiotic stress.

Reference

Cushman, J.C. and Bohnert, H.J. (2000). Genomic approaches to plant stress tolerance. *Current Opinion Plant Biology*, 3:117-24.

Larkindale, J., Hall, J.D., Knight, M.R., Vierling, E. (2005) Heat stress phenotypes of Arabidopsis mutants implicate multiple signaling pathways in the acquisition of thermotolerance. *Plant Physiol* 138: 882–897.

Rodríguez, M., Canales, E., Borrás-Hidalgo, O. (2005). Molecular aspects of abiotic stress in plants. *Biotecnología Aplicada*, 22:1.

20310

10. Trichoderma: As a Potential Agent for Bioremediation

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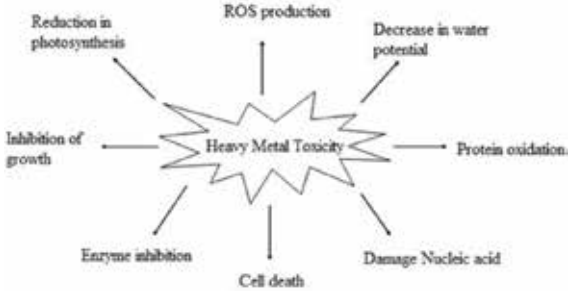
Introduction

Rapid industrialization and increased anthropogenic activities like mining, modern agricultural practices etc results in accumulation of heavy metals in the soil, water and air. The heavy metals like Cu, Cd, Ag, Pb, Ni etc possess a great threat to environment and toxic to plants, animals and humans. As they are non-biodegradable, they cannot be purged out naturally from the environment.

Effect of Heavy Metals on Plants



source- Ashfaque *et al.*, 2016.

Heavy metal accumulation adversely affects plant morphological and molecular activities and causes reduction in crop productivity. Heavy metals (HM) like Cd, As, pb, Cu, Ni etc are environment pollutant, toxic to plants and also possess threat to ecosystem. The high concentration of HM in plants hampers germination, seedling growth, root system architecture, photosynthetic activity, total protein content nd nutrient loss. They not only induce oxidative stress but also causes membrane disintegration and total productivity loss. Plants uptake HM either as soluble components in soil solution or solubilization by root exudates thus becoming toxic to them. HM present in soil also affects the activities of soil microorganisms.

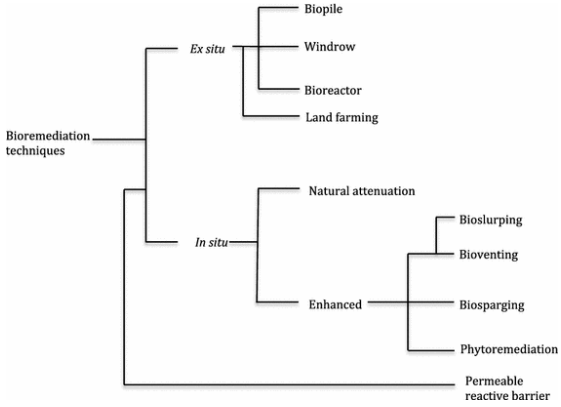
TABLE1: HM, their source and effect on plants.

HM	Source	Effect on plants
Cu	Geogenic, industrial, pharmaceuticals	Cytotoxic, growth retardation, leaf chlorosis, root growth reduction in Rhodes grass.

HM	Source	Effect on plants
Cd	Smelters, fossil fuels, nickel-Cd batteries	Chlorosis, growth inhibition, browning of root tips, cell death decreased nitrate absorption and transport.
Hg	Combustion of fuel, coal burning power plant	Interferes with mitochondrial activity, oxidative stress, disruption of bio-membrane lipids and cellular metabolism
Cr	Metallurgical, refractory and chemical industries, tannery industries	Lipid peroxidation, degradation of photosynthetic pigments, declined growth, reduced seed germination in Echinochloa
Pb	Anthropogenic activities, fossil fuels, mining	Reduced uptake of Ca and P in plant, reduced seed germination in Spartiana, Pinus.
As	Volcanic eruption, soil erosion, anthropogenic activity	Reduction of fruit yield, leaf fresh wt. in tomato, stunted growth

Role of Trichoderma in Remediation of Heavy Metal Toxicity

Bioremediation is widely recognized practice for restoration of heavy metals contamination in the soil. They are eco-friendly and cost-effective as compared to conventional chemical and physical methods. There are various means of remediation of heavy metals discussed below:



Source: Azubuike *et al.*, 2016

Microbial remediation facilitated by use of microorganisms (mo) or genetically engineered microorgnisms which utilizes metabolic potential of the same to degrade contaminants by converting it into innocuous form and their potential to remediate heavy metal has been widely studied. Trichoderma is a wonderful fungus belongs to genus of soil inhabiting, teleomorph bearing filamentous fungi order Hypocreales and division Ascomycota. Trichoderma species are highly resistant to certain contaminants like HM(s), organomettalic compounds, tannery effluents etc. They also play an important role in bioremediation of contaminated soils. Mechanisms by which Trichoderma facilitates HM tolerance in plants is attributed to enhanced production of root biomass, hyperaccumulation of toxicants in plant tissues, protection against oxidative damage and many more. Bioremediation abilities of Trichoderma sp. are mediated through their potential of bioaccumulation, biosorption, biovolatalization and phytobial remediation of contaminated soil, which can be explored vigorously for remediating environmental pollutants.

TABLE 2: Potential role of Trichoderma in remediation

Heavy metal	Trichoderma sp.
Arsenic tolerance in Eucalyptus	*T. harzianum*
Phytoextraction in Cd, Ni contaminated soil	*T. atroviridae*
HM from sludge	*T. atroviridae*
Al resistance in Eucalyptus	*T. harzianum*
Ni, Zn and Cd translocation and uptake in Brassica	*T. atroviridae*
As exposure in chickpea	*Trichoderma* sp.

Thus, various studies show Trichoderma possess a great potential to tolerate and detoxify heavy metal contamination. Although research is required to examine long term effects on stabilization and remediation of contaminated sites and also future studies in bioremediation and regarding Trichoderma is required to develop new methodologies and interaction capacity under different environmental situations.

20332

11. Effect of High Night Temperature on Respiration of Rice (*Oryza sativa*)

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The increasing temperature at night disturbs the metabolism process during the development phase of rice and affect both yield and quality pre and-post harvest. The increasing temperature at night might damage membranes of leaf, which automatically reduce the supply of assimilates for rice grains. Unfortunately, hot days and warmer nights have increased recently. Higher night-time temperatures, in particular, have reduced rice yields, each increasing 1°C might reduce yield of rice for about 10%. Rice is highly susceptible to heat stress, particularly during the reproductive and ripening stages. Extremely high temperatures, even for a few hours, during flowering can cause complete sterility, while high temperatures during ripening can lead to reduced grain filling and poor milling quality.

How HNT Destroys the Crop?

- Total crop biomass of any crop is determined mainly by crop photosynthesis and respiration losses, both of which are sensitive to temperature.
- Global mean surface air temperature increased by 0.5°C in the 20th century and is projected to further increase by 1.5 to 4.5°C in this century. In the past century, daily minimum night time temperature increased at a faster rate than daily maximum temperature in association with a steady increase in atmospheric greenhouse gas concentrations.
- Extreme night time air temperatures adversely affect the milling quality in Rice

Why HNT should be given Emphasis?

- Recent meteorological data indicates faster increase in night temperatures (NT) than day temperatures due to less radiant heat loss because of increased cloudiness
- Experimental evidence also indicates the importance of assessing the effects of NT separately from the day temperature, as a smaller increase in NT can show a drastic decrease in crop production

Response of the Rice plant to varying temperature at different growth stages

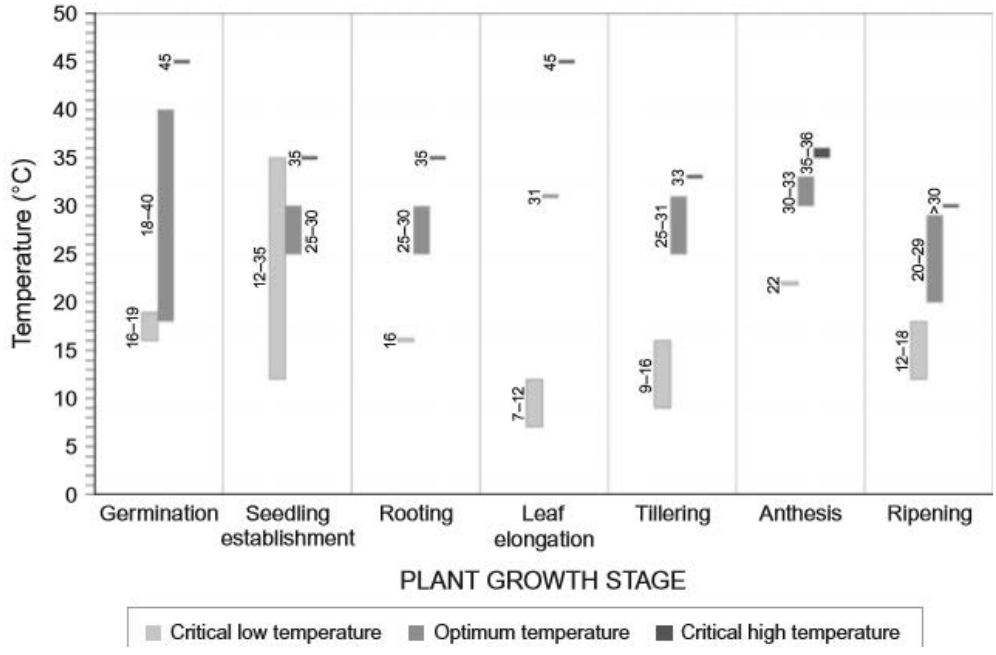

TABLE 1: Response of rice to varying temperature at different growth stages

Growth stage	Critical temperature (°C)		
	Low	Optimum	High
Germination	10	20-35	45
Tillering	9-16	25-31	33
Panicle initiation	15	-	-
Anthesis	22	30-33	35
Ripening	12-18	20-25	30

Yoshida, 1981

How Physiological Processes are affected by HNT?

- High night temperatures (HNT) cause plant responses at the biochemical, physiological and/or genetic level.
- Rice plants exposed to high night temperatures (35 °C) had low CO_2 assimilation due to lower PS-II efficiency and ribulose 1-5 bisphosphate carboxylase/oxidase activity (Yin *et al.*, 2010).
- Higher respiration rates and reduction in photosynthetic rates induces oxidative damage by increasing leaf MDA and proline levels as well as causing changes in leaf photosynthetic pigments, resulting in reduced plant growth in susceptible genotypes.
- Susceptible rice genotypes could show greater membrane damage, greater malondialdehyde and proline levels, and a loss of chlorophyll.

HNT Mitigation Strategies

- Developing tolerant cultivars
- Adopting a late or early maturing cultivar and shifting the crop season
- Adjustment in sowing dates is a simple yet powerful tool for adopting to the effects of potential warming
- Pre-treatment of rice seedlings with low levels of H_2O_2 & NO permits the survival of more green leaf tissue & higher quantum yield for PS-II
- Application of ABA, Salicylic acid & Jasmonic acid is found to enhance the heat tolerance.
- Developing high temperature tolerant transgenic rice through genetic engineering by altering levels of HsPs

[abbreviations; Malondialdehyde (MDA), Abscisic acid (ABA), Hydrogen peroxide (H_2O_2) Nitric Oxide (NO), Hight night temperature (HNT), Carbon dioxide (CO_2), Photosystem- II,

20355

12. How do Plant Response against Heat Stress?

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Introduction

Being a static organism plants are prone to various abiotic and biotic stresses, such as high or low temperature, salinity, drought and insect-pests and diseases. These stresses had an adverse effect directly or indirectly over plant's growth, development, and on over its productivity. In due course of time plants have evolved different biochemical and molecular mechanisms to overcome the maleficious effect of such stresses.

Mechanism Present in Plants against Stress Conditions

Plants responds against stress in both elastic (reversible) and plastic (irreversible) way. These responses are based on intensity, area affected and duration of stress conditions. They have developed different biochemical and molecular mechanisms to overcome the effect of heat stress. These include changes in membrane lipid composition, synthesis of osmoprotectants such as proline, changes in photosynthetic pathway, release of antioxidant enzymes and plant hormones and expression of heat responsive proteins

Antioxidant defense mechanism

Reactive oxygen species (ROS) are produced in plants during various physiological processes but their concentration increases abruptly at the of stress conditions (Zandalinas *et al.*, 2017). This increased level of ROS is a threat to cells because it enhances enzyme inhibition, nucleic acid damage, lipid peroxidation, protein oxidation, and finally activates programmed cell death pathway. In order to overcome this, plants have developed a robust ROS scavenging defense mechanisms, which include both enzymatic (Superoxide dismutases (SOD), Catalase (CAT) Ascorbate peroxidase (APX), Glutathione S-transferase (GST) and Glutathione peroxidase (GPX)) and non-enzymatic (Ascorbate (AsA), Glutathione (GSH), tocopherols, phenolics and carotenoids) antioxidants within the cellular pathways (Muchate *et al.*, 2016).

Compatible solute accumulation

Osmolytes are generally called as small clusters of chemically diverse organic compounds which are hydrophilic in nature. At the time of stress conditions these osmolytes are found to be in large number in plant's cell which is the most common and foremost response of plants against any stress (Ramakrishna & Gokare, 2011). Apart from maintaining osmoregulation in cell they even play a crucial role in protecting proteins from deterioration and scavenging by reactive oxygen species (Kumar *et al.*, 2018).

Hormonal responses against heat stress

Another important defense mechanism available in plants against any stress conditions is phytohormones. Phytohormone like abscisic acid is considered as a stress hormone and during abiotic stress its concentration increases considerably resulting in stress-tolerance in plants. It regulates numerous physiological processes such as closing of stomatal guard cells, mediating solute efflux and regulates the stress responsive genes expression (Zhu, 2016). Another well-known phytohormone produced during stress conditions in plant is ethylene which have direct role in maintaining growth and development of plants during stress conditions (Kazan, 2015).

Transcriptional regulation

Various physiological and biochemical response of plants fasten up the production of the regulatory proteins which finally leads to activation of numerous stress-related genes (Guo *et al.*, 2016). Among all other regulatory proteins, transcription factors (TFs) play an active role in converting the perception of stress signal into a stress-responsive gene expression in plants (Akhtar *et al.*, 2012). They act as a last component of signal transduction chain reactions which results in expression of stress responsive genes expression and finally leads to tolerance against stress in plants (Haq *et al.*, 2019).

Conclusion

A good understanding of all these mechanisms involved in plant tolerance against different stress conditions is of vital significance as it can open up unexplored areas for crop improvement.

References

Akhtar, M., Jaiswal, A., Taj, G., Jaiswal, J. P., Qureshi, M. I., & Singh, N. K. (2012). DREB1/CBF transcription factors: their structure, function and role in abiotic stress tolerance in plants. *Journal of Genetics*, 91, 385–395.

Guo, M., Liu, H. J., Ma, X., Zhen, H. G., & Lu, M. H. (2016). The Plant Heat Stress Transcription Factors (HSFs): Structure, Regulation, and Function in Response to Abiotic Stresses. *Frontiers in Plant Science*, 10.3389.

Haq, S., Khan, A., Ali, M., Khattak, M. A., Gai, W., Zhang, H., Wei A., & Gong. Z. (2019). Heat Shock Proteins: dynamic biomolecules to counter plant biotic and abiotic stresses. *International Journal of Molecular Sciences*, 20(21): 5321.

Kazan, K. (2015). Diverse roles of jasmonates and ethylene in abiotic stress tolerance. *Trends in Plant Sciences*, 20, 219–229.

Kumar, V., Khare, T., Shaikh, S., & Wani, S. (2018). Compatible solutes and abiotic stress tolerance in plants metabolic adaptations in plants during abiotic stress. pp.221-228. 10.1201/b22206-18.

Muchate, S. N., Rajurkar, S. N., Suprasanna, P., Nikalje, C. G., Nikam, D. T. (2016). Plant Salt Stress: Adaptive Responses, Tolerance Mechanism and Bioengineering for Salt Tolerance. *The Botanical Review*, 82, 371–406.

Ramakrishna, A., & Gokare, A. R., (2011). Influence of abiotic stress signals on secondary metabolites in plants. *Plant signaling & behaviour*, 6: 1720–1731.

Zandalinas, S. I., Balfagón, D., Arbona, V., & Gómez-Cadenas, A. (2017). Modulation of antioxidant defense system is associated with combined drought and heat stress tolerance in citrus. *Frontiers in Plant Science*, 10.3389

Zhu, J.K. (2016). Abiotic stress signalling and responses in plants. *Cell*, 167, 313–324.

AGROMETEOROLOGY, REMOTE SENSING AND GIS

20365

13. Trends in Weather Parameters in Uttar Pradesh

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Trend in Weather Parameters

Climate change is a phenomenon that varies spatially and seasonal temperature variation is more crucial in effecting the growth of the crop. Mann Kendall test is a statistical test widely used for the analysis of the trend climatologic and hydrologic studies. Mann Kendall test is the most popular test in testing the monotonic trend in time series data. The trend analysis helps to find out the way weather parameters have changed over time and thus, devise techniques and recommendations accordingly. The annual trend was here analyzed for five districts of Uttar Pradesh.

Annual trends

Trend in annual average rainfall, minimum temperature and maximum temperature were worked out. In case of climate studies, a minimum of 30 years period is required to see the change, thus trend was studies for 1980-2011 period.

There is no trend in maximum temperature was observed for Shahjahanpur and Hardoi districts; while the rest districts increase trend for a period of 1981-2011. The Sen's slope indicates that there is an increase in maximum temperature for Muzaffarnagar, Mirzapur, Lalitpur, Pilibhit and Varanasi districts has increased over the period of 30 years (Table 1).

TABLE 1: Mann-Kendall test output for maximum temperature 1981-2011

	Muzaffarnagar	Mirzapur	Hardoi	Lalitpur	Pilibhit	Shahjahanpur	Varanasi
Z Statistics	2.18	2.9	1.6	3.6	1.2	1.96	3.39
P value	0.02	0.003	0.109	0.0002	0.04	0.05	0.0007
Sen's slope	0.005	0.005	0.00	0.009	0.004	0.004	0.005
Trend	Yes	Yes	No	Yes	Yes	No	Yes
Direction	Positive	Positive	-	Positive	Positive	-	Positive

Significance $\alpha = 0.05$.

In contrast, rise in the minimum temperature was observed in all the districts during the past 30 years. Although this increase was not very much significant, it was at a rate of 0.01 for Lalitpur, Varanasi and Pilibhit (Table 2).

TABLE 2: Mann-Kendall test output minimum temperature for 1981-2011

	Muzaffarnagar	Mirzapur	Hardoi	Lalitpur	Pilibhit	Shahjahanpur	Varanasi
Z Statistics	7.5	6.0	8.33	5.18	8.20	9.17	4.80
P value	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sen's slope	0.01	0.007	0.009	0.01	0.01	0.01	0.01
Trend	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Direction	Positive	Positive	Positive	Positive	Positive	Positive	Positive

Significance $\alpha = 0.05$.

In case of rainfall, the monotonic trend was analyzed mixed results have been observed for the period 1981 to 2011. There is an increasing trend in rainfall for Shahjahanpur, Hardoi and Varanasi districts. While the rainfall has neither increased nor decreased for other districts (Table 3).

TABLE 3: Mann-Kendall test output for rainfall 1981-2011

	Muzaffarnagar	Mirzapur	Hardoi	Lalitpur	Pilibhit	Shahjahanpur	Varanasi
Z Statistics	-0.17	-1.02	-2.32	-0.41	-2.21	-0.46	-1.63
P value	0.86	0.31	0.02	0.68	0.03	0.65	0.10
Sen's slope	0.00	-0.12	0.00	0.00	0.00	0.00	0.00
Trend	No	No	Yes	No	Yes	Yes	No
Direction	-	-	Positive	-	Positive	Positive	-

Significance $\alpha = 0.05$.

Thus, it can be seen that different trend have been observed in rainfall, minimum temperature and maximum temperature for the districts. It shows that the weather parameters vary from place to place and accordingly affect the crop production. For a single state the changing climate, will be different in different agro-climatic zones. Thus, emphasizing the need to develop specific plans to build climate resilience depending on the vulnerability of the area.

References

Choudhury, B. U., Das, A., Ngachan, S. V., Slong, A., Bordoloi, L. J., & Chowdhury, P. (2012). Trend analysis of long-term weather variables in mid altitude Meghalaya, North-East India. *J. Agric. Phys*, *12*(1), 12-22.

Gocic, M., & Trajkovic, S. (2013). Analysis of changes in meteorological variables using Mann-Kendall and Sen's slope estimator statistical tests in Serbia. *Global and Planetary Change*, *100*, 172-182.

WATER MANAGEMENT

20204

14. Soil Moisture Sensors for Irrigation Water Management

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Irrigation scheduling is an important aspect of irrigated agriculture determining the proper quantity and timing of irrigation can have huge impact the water use efficiency. For making better water management decisions knowledge about current status of moisture in field is vital. There are various methods to determine soil moisture ranging from touch and feel method, gravimetric methods to tensiometers and TDR sensors. They are used to measure soil moisture rapidly with great precision and can also be used for real-time monitoring of soil moisture status in field and guide the farmers for making proper irrigation management decisions. These methods don't give direct measure soil-water instead measures certain soil property that can be co-related to status moisture in soil therefore called indirect methods.

Water Potential Sensors

These sensors determine the soil moisture tension/ potential which is the measure of difficulty to remove water from the soil and available water for plants. Some example of water potential sensors like granular matrix sensors and tensiometers.

Tensiometer

They give measurement of soil moisture tension in the root zone. After installation it takes around 2 to 3 hours' time to give response. It is relatively simple instrument that can measures soil moisture tension that is stated in centibars (cbar). High reading of soil moisture tension indicates that the plants have to expend additional energy to abstract water from soil and when tension is low, then plants can extract water with less effort.

Granular matrix sensors

The active portion is the area along the sides of the cylinder with the perforated stainless-steel screen. Inside, it has two electrodes at a fixed distance from each other. Around the electrodes is a fine granulated substance mixed with gypsum. The gypsum buffers the soil solution so the readings are not affected by fertilizer, and naturally occurring ions. All of this is wrapped in a permeable membrane. As soil water enters the sensor, it lessens the electrical resistance between electrodes. A special ohmmeter is used to examine the resistance and this reading is converted into soil moisture reading.

Water Content Sensors

It measures volumetric water content. These sensors indicate the soil water content through time or frequency of a pulse travelling between or returning to electrodes. The common types of these sensors are capacitance and time or frequency domain sensors.

Capacitance sensors

Capacitance sensors generally evaluate several depths at 10 to 20 cm intervals, across the lengths from 40 to 180 cm. Multiple depth measurement provides useful information on water movement through the soil profile and relative moisture content of the soil at different depths. The limitation with most capacitance sensors is that they measure only a very small volume of soil outside the access tube or wall of the sensor.

Time domain reflectometry (TDR)

The time domain reflectometer (TDR) consists of

two parallel rods or plates which are put in the soil to the desired depth where water content is to be measured. The instrument that directs an EM pulse (or wave) along the rod which moves through the soil. The velocity of the reflected pulse is detected and measured which depends upon the dielectric constant this is converted into soil moisture reading. It response time is very quick nearly 28 sec and, it is very easy to use and reliable.

Frequency domain reflectometry (FDR)

In principle it is similar to TDR sensor. FDR sensors are used to measure the soil dielectric constant and this reading is corelated to soil moisture after calibration. It is made up of two or more plates or rods which are put in the soil. In FDR, an oscillating charge is applied to the circuit and its resonant frequency is measured at the other rod or plate. It gives a direct measure of soil volumetric content.

Advantages of Soil Moisture Sensors

- Simple, easy to use and reliable.
- Results are obtained immediately.
- Granular matrix sensors and tensiometers are very cheap.
- High degree of precision results.
- Reduced labour requirements and manual work.
- Offers a larger moisture reading range.

Disadvantages of Soil Moisture Sensors

- High initial costs
- Requires selection of sensors based on site specific
- Requires timely maintained and repairs.
- Sensors are needed to be calibrated for different soil types and site conditions for accurate measurements.
- Requires skilled person for use of sensors and correct interpretation of results.

Conclusion

Use of soil moisture sensors for soil moisture measurements are a very valuable tool for making better irrigation management decisions. Sensors can help in adapting to everchanging environmental conditions and efficient utilization of resources. This technology has to be designed and manufactured keeping in mind the end user so they can be adopted by masses, we need to provide cheaper and reliable sensors to be used by farmers.

References

Garg, A., Munoth, P., & Goyal, R. (2016). Application of soil moisture sensors in agriculture: A review. In: Proceedings of the International Conference on Hydraulics, Water Resources and Coastal Engg., Pune, India. 8-10.

Hanson, R.B., S. Orloff, and D. Peters. (2000). Effectiveness of tensiometers & electrical resistance sensors varies with soil condition. Calif Agric., 54, 47-50.

20253

15. Sustainable Measures to Use Poor Quality Water for Irrigation Purpose

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Quality of water should test to confirm that the plant's growth is proper and to minimize the risk of discharge of contaminants to the surface or groundwater. Quality of irrigation water is an essential aspect of the production of protected cultivation crops. Many variables assess water quality like alkalinity; pH and dissolved salts are among the most relevant. There have been varieties of diverse guidelines on water quality on irrigation water. All have been beneficial, but none have been entirely satisfactory owing to the extensive fluctuations in field conditions.

1. Problems in Irrigated Agriculture due to Water Quality

A) Salinity

Due to water or soil salts, the availability of water to the plant decreases due to which the yield is affected.

B) Water infiltration rate

Comparatively higher sodium or less calcium content in the water or soil slows the rate with which irrigation water enters soil to the degree that

sufficient water could not infiltrate to furnish the plant sufficiently from one irrigation to the next.

C) Toxicity of the ion

Some ions such as (sodium, chloride, or boron) accumulate in sensitive crops by water or soil to such an extent that the crop is damaged, and yield reduce.

D) Diversity

Intense nutrients curtail production or quality; unhealthy fruit or foliage deposits decrease marketability; extreme equipment corrosion tends to increase repairs and maintenance.

E) High alkalinity

High alkalinity water might harmfully affect the pH of the growth medium, disrupt nutrient supply, and trigger nutritional deficiency impairs plant health.

2. Management Options for Saline Water

a) **Crop selection:** Semi-tolerant crops such as Barley, Cotton, Sugar Beet, Mustards, and Wheat, including those with small water demand, are suggested for profitable utilization saltwater.
b) Monocropping suggest for the upkeep of salt amounts.
c) **Conjunctive usage of saline and canal water**: The introduction of the two water sources independently, if accessible on the requirement, such that high saltwater exclude at the plant's critical growth phases.
d) Efforts have often made of using saline water by mixing it with better quality water or by alternate irrigation of higher and lower quality water.
e) Waters of high salinity may use in light texture soils.
f) **Leaching Requirement (L.R.):** The leaching requirement is being described as a portion of the irrigation water, which must be leached through the root zone to regulate soil salinity at a particular absolute level. This concept was placed by (Richards, 1954).
g) The detrimental impact of the high salinity of irrigation water on crops can indeed mitigated by recurring irrigation. More repeated irrigations sustain high soil moisture content in the upper part of the root zone while decreasing the concentration of soluble salts.
h) **Cultural practices:** Cultural strategy can also be adjusted to lower the risk of high salts in irrigation water.

3. Management Options for Alkali Water

a) Use of Amendments-Gypsum
b) The control of alkaline waters could include traditional irrigation techniques, such as basin irrigation.
c) Integrated use of Alkali and canal water.
d) Low water-induced cultivations. Water with considerable residual sodium carbonate (RSC) amounts should be employed in limited quantities of water when irrigation water tends to generate sodium problems, and therefore the need to limit water utilization causes a steady rise of the exchangeable sodium status of soils.
e) Application of organic matter, heavy manure dressings, regular use of plant residues, the use of natural materials, such as rice hulls, sawdust, sugar, etc. have been found beneficial to preserve and enhance the physical properties of soil and to overcome the difficulty of high sodium exchanges. So organic matter utilization recommended, particularly if water irrigation has a sodium hazard wherever possible.

4. Agricultural Water has been describing as a Major Risk Factor for Leafy Crops being Eaten Raw as Salads to become Polluted

- More green and sustainable technologies based on physical treatment, including U.V., ultrasound (U.S.), and filtration, were tested to eliminate microbial irrigation water stress.
- Recent research on commercial agricultural production sites has shown a significant reduction in the risk of microbial contamination of fresh produce by the use of low-quality irrigation water incorporate with the use of soilless production systems (Lopez *et al.*, 2014: Luedtke *et al.*, 2003).

5. The High RSC Content can be Fix by Adding Gypsum, and Water can be used for Irrigation

TABLE 1. Groundwater quality status in selected states of India.

State	Utilizable groundwater resource (M ha –m yr^{-1})	Use of poor-quality water (M ha –m yr^{-1})	Area underlain by saline groundwater (E.C.> 4 dS m^{-1}) Km^2
Punjab	1.47	0.68	3,058
Haryana	0.86	0.47	11,438
U.P.	6.31	1.42	1,362
Rajasthan	0.95	0.65	1,41,036
Gujarat	1.56	0.26	24,300
Karnataka	1.24	0.17	8,804
Tamil Nadu	2.02	NA	3,300
All India	**32.63**	**NA**	**1,93,438**

Source: Sharma and Minhas, 2006

Conclusions

1. Poor quality water impacts the physical, chemical, and biological properties of soil directly and indirectly and decreases crop growth and economic performance.
2. Selection of cultures, crop patterns, and crop verities producing high yields.
3. Optimum use of chemical additives with the prudent use of organic substances and natural fertilizer, including time and manner of application.

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References

Richards, L.A. (1954). Diagnosis and improvements of saline and alkali soils. USDA. Agriculture Handbook 60. pp.160.

Lopez, G.F., Allende, A., Pedrero, S. F., Alarcon, J.J. and Gil, M.I. (2014). Safety assessment of greenhouse hydroponic tomatoes irrigated with reclaimed and surface water. *Int. J. Food Microbiol.* **191:** pp. 97–102.

Luedtke, A.N., Chapman, B. and Powell D.A. (2003). Implementation and analysis of an on-farm food safety program for the production of greenhouse vegetables. *J. Food Prot.***66**: pp. 485–489.

Sharma, D.R. and Minhas, P.S. (2006). *Management options and policy guidelines for use of poor quality groundwater in agriculture*, No. H039316, IWMI Books, Reports, International Water Management Institute.

ORGANIC FARMING

20249

16. Organic Certification in India

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Now a day's everyone believes that 'Health is wealth,' and this is the region behind the demand of organic product to sky-high day by day. Practicing organic systems over a long period of time can also provide equal yields or even more the conventional methods. In India, it is like to some extent 'Old wine in a new bottle.' Here it is a traditional method of farming without the use of chemical fertilizers and pesticides with an environmentally viable and socially responsible approach. The rank of India in terms of the world's organic agriculture land was 9th and in terms of total number of products was 1st (FIBL and IFOM yearbook, 2018). So, there is undoubtedly a huge scope for the Indian capitalist, progressive farmer and specially the youth to come forward and make their remarkable presence in upcoming, promising worldwide business.

If we really compete the global market, at first, we should go through the certification process the trademark - "India Organic". It is a label given to organic products after validation, which ensures that the product or raw materials used in the product were grown through organic farming - without any chemical fertilizers, pesticides, or induced hormones. Indian organic certification (IOC) process granted worldwide in 2004 and in 2006, India's organic certification process under NPOP has been accepted as equivalent to European Union. It has also been recognized for conformity assessment by USDA's NOP. Someone having certificate will get so many benefits like support with loan for their business from National Bank for Agriculture and Development Act (NABARD) and he/she can easily export their commodities to abroad. The government will give the certificate holder subsidies in many schemes, like- Udyog Adgar. For facilitate the foreign export one should also register under Food Safety and Standers Authority of India (FSSAI).

Anybody having organic farm can resister their business under the National Program for Organic Production. (NPOP). Farmers who are producing high value, export demandable agricultural commodities in a large scale or small size land holder growers' groups (minimum of 25 and maximum of 500 farmers having lands in the same geographical area) can apply for Organic certification of their produce. The NPOP programme was launched at 2001 and it comes under Foreign trade development and regulation act (FTDR)

which is responsible for export requirement. In our country Agriculture and processed food products, export development (APEDA) which comes under the ministry of commerce, regulates NPOP. NPOP set some standard for organic farm as well as according to the crops. So that quality of the product will increase and compete with the world market. For certification you have to meet the principle standards given by NPOP.

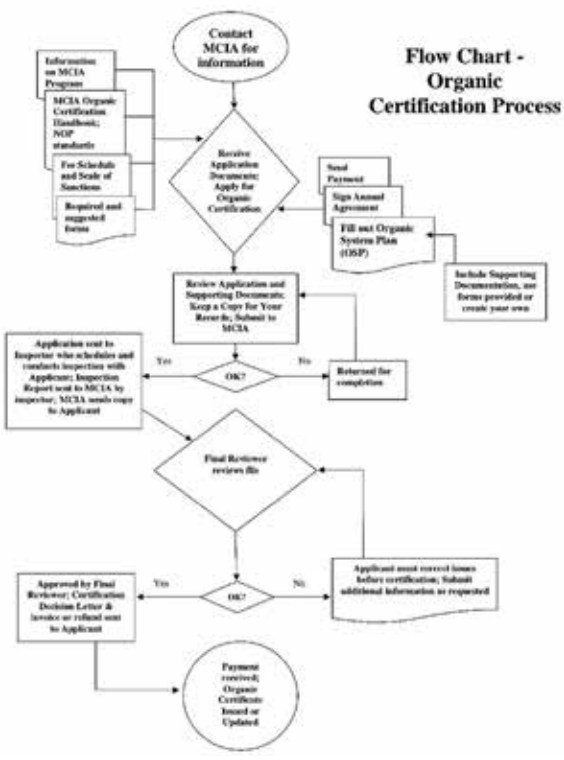

FIG. 1: Organic certification process

Principal of Standards

1. Conversion of land for Organic Farming must be done.
2. All inputs to the farm should be natural.
3. No Genetically Modified inputs or Irradiation technology should be used.
4. Integrity of all processes (physical, biological, mechanical) must be maintained at all times.
5. No contamination from nearby farms or other means must be present.
6. Sustainable practices must be followed in the farm.

After fulfill the standard principle of NPOP, you can apply for certification to APEDA accredited body. There are so many APEDA accredited bodies working all over India like-IMO Control Pvt. Ltd., Indian Organic Certification Agency, Natural Organic Certification Agency, SGS India Pvt. Ltd., Vedic Organic Certification Agency etc. The total cost of India Organic label will be calculated depending upon the application fee, site inspection fee and an annual certification fee which can be vary 10,000-60,000 depending on the type of product, size of the production area and the accredited agency one chooses. For successfully running the business everyone has to renew the certificate in every 3 years.

SOIL SCIENCE

20230

17. Direct Benefit Transfer Scheme in Fertilizer Subsidy

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Introduction

Fertilizer is the pivotal input for agricultural production which is the pillar of Indian economy. India is the second-largest consumer of fertilizer in the world after China. Fertilizer subsidies were introduced by Government of India after 1977 to ensure price stability and efficient distribution to farmers. Fertilizer subsidy in India occupies a significant position (750 billion for the year 2019-20) when compared with total subsidy given by government. The government spends nearly 30 per cent of its total subsidy on food, fuel and fertilizer

to provide key agriculture input at cheaper rates.

For growth of agriculture sector, timely availability of fertilizers as input to the farmer at affordable prices is crucial. Subsidy schemes have been an integral part of Government policy to sustain agricultural productivity which in turn plays prominent role in ensuring the food security in promoting rural livelihood and employment. Fertilizer subsidy is the second largest subsidy program of government after food.

The Government of India introduced a digital initiative *i.e.* Direct Benefit Transfer (DBT) system for payment of fertilizer subsidy on pilot basis in 19 districts of 14 States in October, 2016 and for all other States the programme would be launched w.e.f. 1st January, 2018 with a view to improve the quality of service delivery to farmers. Under the fertilizer DBT system, fertilizers are sold to farmer at subsidized market price through Point of Sale (PoS) devices installed at each retailer shop through biometric Aadhar based authentication and subsidy amount is paid by government directly to the fertilizer companies on the behalf of farmer.

The government launched the DBT Fertilizer program with the following objectives:

- To set up an efficient fertilizer subsidy distribution model;
- To study fertilizer consumption at the farmer-level and encourage balanced use of fertilizer through soil health card recommendation;
- To identify the genuine recipient of fertilizer subsidies;
- To digitize the sale of fertilizer through point of sale;
- To trace and attenuate the excessive use of fertilizer;
- To account for subsidy payments to the manufacturers and thereby reduce the fertilizer subsidy load on the government; and
- To plan estimates of fertilizer demand

Benefits of DBT in Fertilizer Subsidy

- Aadhaar seeded data base of beneficiaries is created
- Transaction transparency is ensured
- Over pricing of fertilizers is minimized
- Efficiency in supply chain is ensured
- Actual sales are linked to subsidy payments
- Ultimate beneficiaries are targeted
- Black marketing of fertilizers is controlled
- Linking of Soil Health Card Data with DBT, would lead to balanced use of nutrients and also will result in saving subsidy.
- Minimize leakage and diversion of fertilizers

20232

18. SIS: New Approach for Land Evaluation

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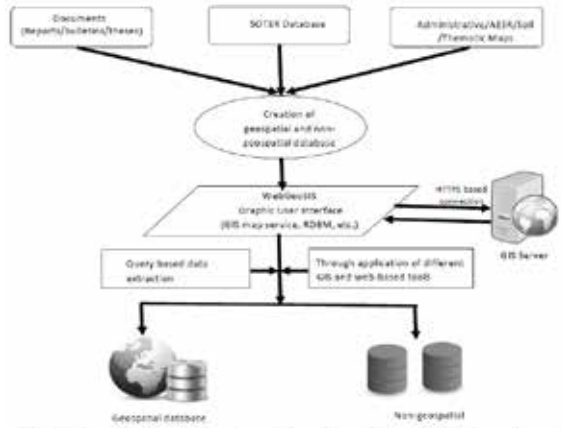
Introduction

Soil information system based on database obtained through remote sensing and ground survey in combination with Geographic Information System and decision support systems can be developed. As GIS supports spatial query and display of results in the system has immense potential in planning, judicious management, conservation and sustainable use of soil, land and crop resources. "It is a computerized database system where soil and related data can be organized, stored, retrieved, analyzed and processed to make it accessible to end-users in the form of Maps and tables". It is based on a database obtained through RS and ground survey in combination with GIS.



Schematic diagram showing web-based geo referenced soil information system and its structural framework

Tools of SIS

- GPS
- Satellite remote sensing

- GIS

Global Positioning System (GPS)

It is a space - based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the earth where there is an unobstructed line of sight to four or more GPS satellites.

Working principle

Remote sensing

Satellite remote sensing has been extensively utilized for inventory, mapping and assessment of natural resources. This also envisages to make use of the satellite data acquired at periodic intervals to monitor the land resources and evaluate land cover changes and its impact on environment.

Geographical information system (GIS)

It is a tool for analyzing and integrating the spatial and non-spatial data. It can be used as – an information database, an analytical tool and as a decision support system.

Most used tools in GIS for the soil information system

- ***Geo-referencing*** – Process of assigning real-world coordinate to each pixel of the raster.
- ***Geo-rectification*** – Digital alignment of satellite or aerial photograph.
- ***Image interpretation*** – Examining an aerial photograph or digital remote sensing image and manually identifying the features in that image.
- ***Digitization*** – The conversion of text, pictures or sound into a digital form that can be processed by a computer.
- ***Preparation of maps***
  - ***Interpolation:*** Estimating the attribute values of locations that are within the range of available data using known data values
  - ***Extrapolation:*** Estimating the attribute values of locations outside the range of available data using known data values

Conclusion

The use of geostatistical techniques and geographical information systems (GIS) leads to a rapid generation of thematic maps and area estimates, and enables many of the analytical operations to be carried out in a spatial format for example, by combining different sets of information in various ways to produce overlays and interpreted maps. Also, digital satellite imagery can be incorporated directly into many GIS packages. for example, by combining different sets of information in various ways to produce overlays and interpreted maps. Also, digital satellite imagery can be incorporated directly into many GIS packages. This technology is already a prerequisite for managing the massive data required for land evaluation. Although the new development and application needs in land evaluation must be considered location specific, some general trends can be indicated. In this sense, it is clear that the rapid development of information and communication technologies will be a powerful tool in incorporating new information sources (*e.g.*, satellite images, digital elevation models), extracting maximum value from data (*e.g.*, Internet-accessible databases and sophisticated modeling techniques), and increasing the availability of the end products (*e.g.*, low-cost spatial viewers).

20238

19. Rhizosphere Priming Effect

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Soil organic carbon (SOC) is an important source and sink of atmospheric carbon dioxide (CO_2) as soil contain 10 times more carbon than atmosphere. Soil CO_2 efflux combined with that of above ground plant biomass (soil stock more than 2300 Pg C within top 3m of its surface) is one of the largest effluxes of C to atmosphere from earth. Soil CO_2 efflux is approximately 10 times more than CO_2 efflux from earth through anthropogenic activities. Significant part CO_2 efflux is contributed by the turnover of the soil microbial biomass, which depend on environmental changes. The concept of priming effect was evolved the describe the changes in soil organic matter (SOM) decomposition as altered by introduction of any substances either it be organic or mineral. Addition of organic substances in soil may increase or retard SOM decomposition which in broader term known

as positive or negative priming effect. In general, positive priming effect is proportional to the amount of C in added substrate. Stronger priming effects were shown by complex organic substrates like green manures, rye grass and wheat straw in comparison to glucose and fructose as direct energy substrate. Priming effect is of two type: apparent priming, which accounts the change in the CO_2 efflux from turnover of microbial biomass after the addition of easy-available substrates, and real priming, which accounts the change in CO_2 efflux from soil organic matter. These two types of priming which are difficult to differentiate, but apparent priming occur soon after addition of readily available substrates, while real priming take to be active. Jenkinson *et al.* (1985) described that real priming effect is an increase in the decomposition rate of recalcitrant SOM, while apparent priming effect is an increase of turnover of microbial C, which is not related with changes of SOM decomposition. Priming under plant cultivation occurs in the vicinity of living plant roots. Therefore, priming under such condition called as rhizosphere priming.

Priming Effect as Affected to Substrate and Soil Properties

Decomposition of SOM depend on many factors like amount of substrate but also on quality of organic substances and availability of decomposers. Greater priming effect results through decomposition of direct C sources (glucose, fructose, and alanine) and smaller priming effect by addition of low available substrates, such as catechol, oxalic acid, plant residues, manure, or slurry to soil. Amount of available N in soil is a key factor which affect the process of rhizosphere priming and primed carbon. Addition of readily available forms of N in soil with organic carbon decrease the priming effect. The synthesis and the activity of various enzymes in rhizosphere which are involved in C and N cycling are, respectively, depend on N and C availability. Thus, addition of N stimulated the activity of cellulases, while the activity of phenoloxidase (ligninolytic enzyme) was greatly hampered by the increased N level. The higher and positive values of priming effect occur in neutral soil having pH range 6 to 8. Other soil properties like aggregate and particle size fractions play an important role in modulating priming effect. Microaggregates can store C for longer time duration than macroaggregates. This property of aggregates affects the priming effect as enzyme activity is also influenced by this property of soil.

Mechanism of Rhizosphere Priming Effect

- **Rewetting hypothesis:** Alternate wetting and drying condition in top soil, could accelerate decomposition of SOM.
- **Aggregated destruction hypothesis:** Growing roots of plants disturb the formation of aggregates which in turn expose the SOM hidden in the aggregated and promote decomposition.
- **Root uptake of soluble organic substances:** Sometimes uptake of exudates from rhizosphere is more by plant roots which decrease the carbon source available for microbes. So, the microbial activity in the rhizosphere decreased and decomposition is retarded.
- **Enhancing microbial turnover due to faunal grazing:** Faunal grazing means microorganism predation which increase microbial turnover and SOM decomposition.
- **Competition for N between plant roots and rhizospheric microorganism:** Available N in the rhizosphere is the major limited factor. Increased uptake of N by plant roots decrease the microbial activity and SOM decomposition.
- **Preferential substrate utilization:** Substrate with easily decomposable structure are preferred first to utilize than SOM.
- **Microbial activation:** Plant roots release easily available substances which are attacked by microorganism and this phenomenon lead to microbial activation at large scale for SOM decomposition.

20272

20. Acid Sulphate Soil: A Neglected Threat to Sustainable Crop Production

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Acid Sulphate Soil: Outlook

Soils and sediments formed under submerged conditions comprising of iron sulphide minerals (reduced and/or oxidized) are termed as acid sulphate soils (Acid_sulphate_soils, n.d.). These are distributed in 17.1 million hectares globally covering low-lying coastal areas of South East Asia, West Africa, northeastern South America as well as minor pockets of North America, Europe and Middle East. It is also found along the coastline of Indian subcontinent.

Kinds of Acid Sulphate Soil

Acid sulphate soils are categorized as Potential acid sulphate soil (PASS) and Actual acid sulphate soil (AASS) based on pH.

Potential acid sulphate soil (PASS)

Iron sulphide minerals remains stabilized under undisturbed anoxic condition and the soil pH remains slightly acidic/neutral/slightly alkaline, such soils are called as potential acid sulphate (PASS) soil. It has the potential to form AASS under the influence of atmospheric oxygen.

Actual acid sulphate soil (AASS)

When PASS is excavated, iron sulphide minerals are oxidized to H_2SO_4 under the exposure of oxidizing environment and creates an extremely acidic situation (pH < 4). These soils are called as actual acid sulphate soil (AASS).

Genesis And Chemistry of Formation of Acid Sulphate Soils

Marine sulphate (SO_4^{-2}) mixes with iron oxides and organic matter during inundation. Under such anoxia, bacteria such as *Thiobacillus ferroxidans* form iron sulphides (pyrite). Supplies of sulphur, reducing condition, organic matter and tides are essential for the formation of acid sulphate soils.

Under waterlogged anaerobic soils, sulphate derived from the seawater is reduced to S^{2-} by anaerobic microbes such as *Desulfovibrio* and *Desulfotomaculum*. Ferrous and ferric sulphides ($FeS + FeS_2$) are formed *via* siltation. When such soils are exposed to air coupled with draining of sea water, acidification occurs with the following reaction as-

$$2FeS_2 + 9O_2 + 4H_2O \rightarrow 8H^+ + 4SO_4^{-2} + 2Fe(OH)_3$$
(solid)

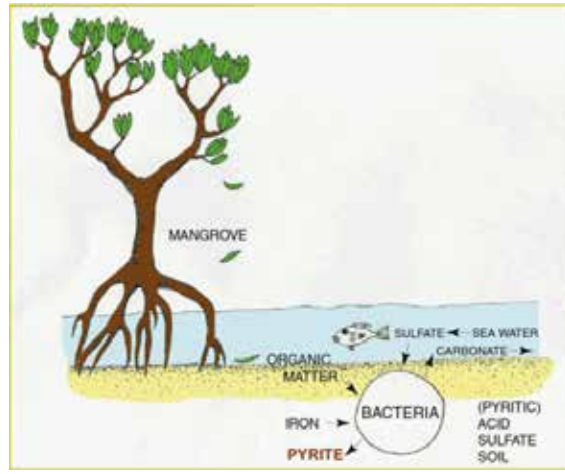

FIGURE 1: Formation of acid sulphate soils (www.qld.gov.au)

Impacts of ASS

- Acid sulphate soil lowers down productivity by imparting nutrient deficiency and toxicity.
- It creates a serious threat to crop production by inhibiting root growth and inducing water stress.
- Aquatic and estuarine ecosystems are affected by acidification, toxicity of iron causing death of fish and other aquatic animals, etc.
- Release of heavy metals and metalloids (arsenic, aluminium, chromium etc) causes groundwater pollution.
- It shows corrosive effects on concrete and steel pipes, bridges etc.

Management of Acid Sulphate Soils

Management of ASS involves different strategies namely-

Avoidance

The most environmentally benign and cheapest

technique is to avoid acid sulphate soil affected areas by not carrying out any excavation work.

Minimization of disturbance

Soils are advised to be undisturbed by reduction in groundwater fluctuations, submergence, capping of sulphide layers and minimization of opportunity for exposure to oxidation.

Neutralization

Neutralization is the most commonly applied technique that involves addition of neutralizing materials (lime) into the soil.

Oxidation and leaching

Acid sulphate soils are spread into thin layer to have high rate of oxidation and leached out using specific solvents.

Removal of pyritic materials

This is the exotic as well as most expensive procedure involving slucing and hydrocycloning techniques for the complete removal of pyrites.

Conclusion

Acid sulphate soil under soil acidity is one of the numerous threats limiting the sustainability of agricultural production. Productivity of such soil is severely restricted by deficiencies of nutrients, the toxicity of elements, and substandard microbial activity. Therefore, holistic knowledge of its formation, chemistry, characteristics, and limitation is necessary to snowball an economically viable and ecologically sound management technique to maximize agricultural productivity for ensuring food and nutritional security.

References

Acid_sulfate_soil. Retrieved from https://www.chemeurope.com/en/encyclopedia/Acid_sulfate_soil.html on June 14, 2020

Acid_sulfate_soils_explained. Retrieved from https://www.qld.gov.au/environment/land/management/soil/acid-sulfate/explained on June 13, 2020.

20275

21. Sulphur Transformation in Soil

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Recognition of the existence in soil of Chemolithotrophic bacteria capable of oxidizing sulphur occurred almost simultaneously with the discovery of the nitrifying bacteria. Certain bacteria were able to obtain their growth energy by oxidizing sulphur to sulphate. Most of the early studies of the microbial transformations of sulphur in nature were concerned with the geochemistry of marine sediments and the formation of sulphide ores.

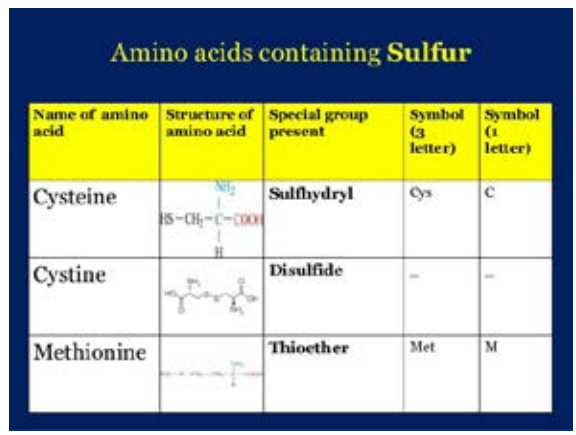
Forms of sulphur in soil

1. Organic forms
2. Inorganic forms

Total sulphur content in soils varied less than 20 ppm (0.002%) to more than 600 ppm (0.06%) depending upon soil types.

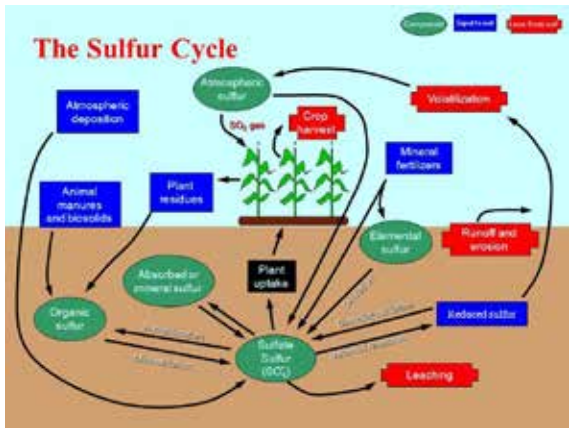
Fraction of Organic form of Sulphur

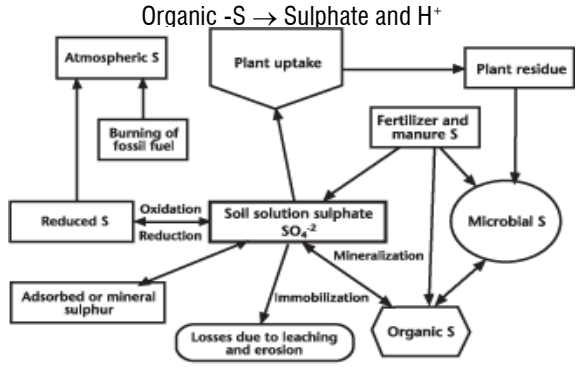
1. *Carbon bounded:* S: *e.g.,* Amino acids like cysteine, cystine and methionine
2. *Non- carbon bounded:* S: *e.g.*, Esters, phenolic and choline sulphate and lipids.



The Sulphur Cycle

Sulphur is present mainly in soil and is thus susceptible to leaching from the soil. In humid region soils, bulk of the sulphur is associated mainly with organic matter, which is mineralized by soil microorganisms in sulphate-S, Sulphur cycle shows the relationships among atmosphere, fertilizer and soil sulphur (Fig).





Mineralization of S- Compounds in Soils

The sulphur in soil is cycled continuously between inorganic and organic forms.

Organic matter is the major source of soil sulphur.

Its oxidation to SO_4^{2-} is brought about by soil M.O., process is called Mineralization. This mineralized S is taken by plants microorganism.

The rate of mineralization is affected by factors such as moisture, aeration, temperature and soil PH.

The conversion of organic S to SO_4^{2-} is an oxidation process. It cannot take place in absence of oxygen. Therefore proper aeration is essential for this reaction. Also, this process cannot take place under submerged soil conditions except in the aerated pockets of the soil.

The mineralization process can be expressed by equation

Under the limited S supply and in the presence of excess of carbonaceous materials. The mineralized S, readily utilized by microorganisms here carbonaceous materials provide energy to the Growing population of microorganisms. Which consume the mineralized -S. Hence crop plants may suffer from S deficiency. This process is called immobilization.

Immobilization is a temporary phase, as on the death of the microbial population, the microbial –S is mineralized to sulphate which can be utilized by growing plants. Sulphur in the soil is associated with organic carbon in a fixed C : S ratio. Thus, a favourable C: S ratio is more important than a large store of organic matter for response under tropical conditions. This is because the ratio influences microbial decomposition of OM. Since this transformation is mediated biologically, extremes of temperature hamper this process. Optimum moisture is 60% of field capacity.

20280

22. Site Specific Nutrient Management (SSNM): Key to Secondary and Pollutant Elements

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Site-specific nutrient management (SSNM) is a plant-based approach, which is a component of precision agriculture, that allows for improving crop management systems. The key principles of SSNM include the identification of yield – target with respect to the yield potential, estimation of indigenous nutrient supplying capacity using a nutrient omission approach (nutrient- limited yield), estimation of nutrient requirements based on an expected yield gain, dynamic field- specific application of fertilizers, dynamic field- specific application of fertilizer-N during the growing season including the use of a leaf color chat (LCC) and selection of P_2O_5 and K_2O rates sufficient to overcome deficiencies and avoid nutrient depletion from soil.

Strategies of SSNM

Before finalizing the nutrient- Based fertilizer

application to a specific crop, it requires to analyse the soil for primary, secondary and heavy metals (if there is any) concentration which may affect the production potential of the crop as well as nutrient use efficiency (NUE) of the applied fertilizer to the soil. The strategies for SSNM that assess nutrient requirements of crops, nutrient supplying capacity of soil and recovery efficiency of applied fertilizers, could be used to increase yield of crop and nutrient use efficiency. The principle to determine field- and season- specific fertilizer application has been applied successfully on rice, wheat and maize.

Consequently, the concept of "feed the crop as needed" has been shown to increase the economic viability of rice farming for farmers (Peng *et al.*, 2010). A number of studies have shown that SSNM could optimize nutrient management for given soil fertility in irrigated ecosystems. A dissemination programme of SSNM for irrigated-rice through a decision-support software (Nutrient Manager for Rice, upgraded to Rice Crop Manager, hereafter RCM) was conceptualized for implementation at different locations of South – Asian regions.

Secondary and Pollutant Elements

It has been observed that overuse of fertilizers has resulted in contamination of surface water and groundwater. The residual action of pesticides containing heavy metals (Pb, Cd, Cr, As, Ni etc.) have long term effects on human beings through food chain.

Bio solids, which are nutrient- rich organic materials resulting from the treatment of domestic sewage in a treatment facility can be recycled and applied as fertilizer to improve and maintain productive soils and stimulate plant growth. Their use can enhance the water quality, pollution prevention and sustainable agriculture. The sewage/sludge used in agriculture should come under the regulations of EPA (Environmental Protection Agency) and under the Clear water Act which is currently subject to concentration limits for the metals like arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, zinc. If the fertilizers are made from the waste, care should be taken on the maximum permissible concentration of heavy metals in products as per EPA's long-standing policy which will examine whether some fertilizers or soil conditioners contain potentially harmful containment levels when properly manufactured and applied. Hence, Agricultural producers must demonstrate that there is no substantial risk to human health caused by the growth of such crops.

Prominence of SSNM

This approach can provide effective guidance in relation to the problems and prospects of targeted yield of crops at farmers' field. It ultimately improves the farmers' income by reducing cost of production. The greenhouse gas (GHG) emissions can also be reduced by minimizing overuse of fertilizers in the field. The principles of SSNM are generic and applicable to most of the crops including rice.

Hence, the promotion and adoption of SSNM depends on how precisely there is nutrient management by the stakeholders at their field for maximizing the yield of crop.

References

Peng, S., Buresh, R.J. Huang, J. (2010) Improving nitrogen fertilization in rice by site- specific N management. A review. *Agron. Sustain. Dev.* 30: 649-656. doi: 10.1051/agro/2010002

20315

23. Pressmud: A Potential Soil Conditioner to Sustain Soil Health

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Sugarcane (*Saccharum officinarum*) is the extensively grown crop among the tropical and sub-tropical countries such as Brazil, India, China, Pakistan, Mexico and Thailand. India ranks the largest consumer and second most producer of sugarcane in World after Brazil. In 2017-18, The area under sugarcane was 4732 (000 Ha) with production of 376,905 (000 Tonnes) with 525 active no. of sugar producing factories. The by-products of Sugar industries are: Pressmud (also known as Filter cake or Filter mud), Molasses, cane Top and Bagasse (Fig. 1).

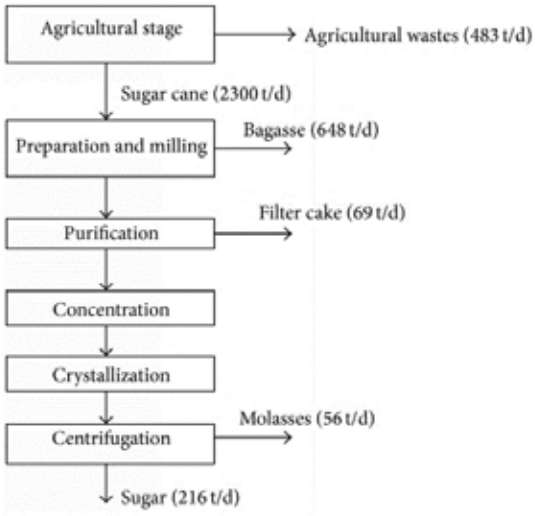

FIG. 1 By-Products of Sugar Industry

FIG. 2 Pressmud

TABLE 1 Constituents of Pressmud

Constituents	%
Moisture	50-65
Fiber	20-30
Crude wax	7-15
Sugar	5-12
Crude protein	5-10
Nitrogen	2-2.5

The pressmud is dark brown amorphous spongy material and a good source of organic matter. It is the major residual product left after filtration or purification of extracted cane juice either through carbonation or sulphitation process. When 100 t of sugarcane is crushed, it produced around 3t of pressmud cake (Kumar *et al.*, 2017). But it is considered as discarded material and creates environmental pollution by its accumulation near to sugar industries or another huge problem is its storage. The pressmud contains approximate amount of organic matter, phosphorus, iron, calcium, magnesium, manganese, silicon and some other major constituent as displayed in Table 1. So, it has been used as a source of nutrient supply in various countries including India for the production of Sugarcane or other crops. It can also be used as soil amendment for acidic and alkali soils. Carbonated press mud could be used for reclamation of Acidic soils and Sulphitation pressmud for alkali soil reclamation.

Effect of Pressmud on Soil Properties

1. Physical
   a) Use of several organic amendments leads to prevention of soil compaction, erosion, and desertification
   b) Improvement of soil aggregation through its effects on soil water content, temperature, aeration and mechanical impedance
   c) Improved soil structure and aeration
   d) Increased water-holding capacity
   e) Increased availability of water to plants
   f) Reduced compaction and hardpan conditions
   g) Improved tile drainage effectiveness
   h) Better root development
   i) Higher yields and quality
2. Chemical
   a) Soil amendment with organic materials such as sewage sludge, plant residues, compost, and chicken manure are well known environmental practices in soil restoration, maintaining soil organic matter and supplying plant nutrients
   b) Reclaiming degraded soils such as Alkali or acidic soil reclamation
   c) Release of "locked" nutrients
   d) Better chemical incorporation
   e) It is also known to increase cation exchange capacity (CEC) and retention of cationic nutrients namely potassium (K), magnesium (Mg), calcium (Ca), and ammonium-N.
   f) Increase in buffering capacity of soils
   g) Reduction in $CaCO_3$ content of soils through release of organic acids
3. Biological
   a) Supplies substrate in the form of carbon to microbes thereby stimulating microbial diversity and activity
   b) In addition, soil microbial respiration was higher in soils with organic amendments indicating higher microbial activity
   c) The incorporation of cover crops or other organic soil amendments significantly improve the enzymatic activities in soil.

So, utilizing sugarcane by-product *i.e.*, Pressmud in agriculture not only improves soil

quality but also solves its disposal problem. It protects the crop from soil borne diseases. Various Studies has been conducted and showed the potential of Pressmud to improve the crop yield. Yang *et al.*, 2013 conducted an experiment and compared the effect of Vinasse (Liquid by-product of alcohol industry) and Pressmud with the chemical fertilizer. The dose of vinasse and pressmud applied was 120 t ha^{-1} and 150,000 kg ha^{-1}, respectively in the field. They found decrease in the soil pH and increase in total Carbon and nitrogen content with pressmud application compared to Chemical fertilizer. The soil recorded maximum population of Fungi and Bacteria with pressmud application compared to Chemical and Vinasse treatment as their population is largely dependent upon organic matter content. The soil enzymatic activities such as cellulase, aminopeptidase and phosphatase were also found significantly higher in pressmud treated soils. They concluded that pressmud has potential to substitute chemical fertilizer and effect soil health positively.

References

Casas Cardoso, L., Hernandez, Y., Mantell, C., Casdelo, N., and Martinez de la Ossa, E. (2015). Filter Cake Oil-Wax as Raw Material for the Production of Biodiesel: Analysis of the Extraction Process and the Trans-Esterification Reaction. *Journal of Chemistry*, 1-9.

Yang, S., Liu, J., Wu, J., Tan, H., and Li, Y. (2013). Effects of Vinasse and Pressmud Application on the Biological Properties of Soils and Productivity of Sugarcane. *Sugar Tech*, 15:152-158.

Kumar, S., Meena, R. S., Jinger, D., Jatav, H. and Banjara, T. (2017). Use of pressmud compost for improving crop productivity and soil health. *International Journal of Chemical Studies*, 5(2): 384-389.

20357

24. Monitoring of Soil Quality by Modern Techniques

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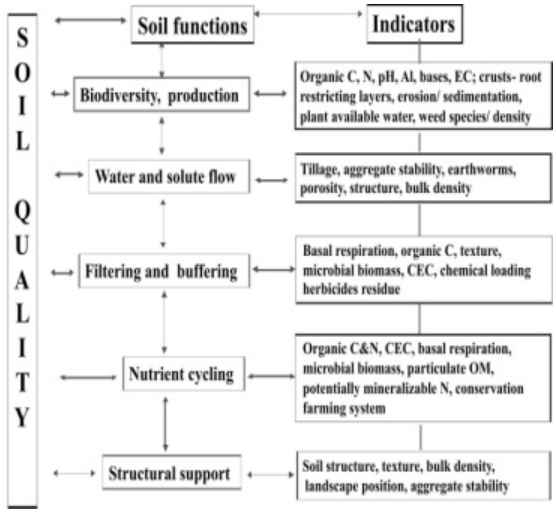
Introduction

The word "monitoring" has different meanings, and it will be defined here as regular observations in a time series designed to give information about the environment so that past and existing states can be assessed and future trends predicted in any environmental features which may be important to man. Soil quality is the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation. The terms soil quality (favored by scientists) and soil health (favored by farmers) tends to be used interchangeably, especially in the general press. Characterization of soil quality by scientists focuses on analytical/quantitative properties of soil with a separately defined quantitative link to the functions of soil quality. Soil quality indicators are physical, chemical, and biological properties, processes, and characteristics that can be measured to monitor changes in the soil. Some of the indicators that are used for land evaluation visual, physical, chemical, and biological. Land evaluation can be an appropriate procedure for analyzing the soil physical quality from the point of view of the long-term changes. Then, a short-term evaluation and monitoring procedure can be considered mainly for the soil biological quality and metal pollution of soil. Protect the soils with regard to sustainable land use.



Graphical Representation of the Concept of Soil Quality

Approaches

- Fertilizer Application based on own/peer Perception
- Soil-test-based Fertilizer Recommendation
- Integrated nutrient management strategies for different cropping systems

- Linking soil fertility maps with nutrient supply/uptake parameters for spatial fertilizer recommendation
- Decision Support System for Integrated Fertilizer Recommendation (DSSIFER) is user-friendly software.

On-line fertilizer recommendation systems – DSS http://www.stcr.gov.in

The AICRP on STCR has developed a computer-aided model that calculates the amount of nutrients required for specific yield targets of crops based on farmers' soil test data

LAUNCH OF SOIL HEALTH CARD

- Fertilizer recommendation based on STCR equations or GFR.
- Soil Health Card generation along with fertilizer recommendation and amendment suggestions
- Management Information System (MIS) monitoring progress

The USDA-NRCS soil quality test kit

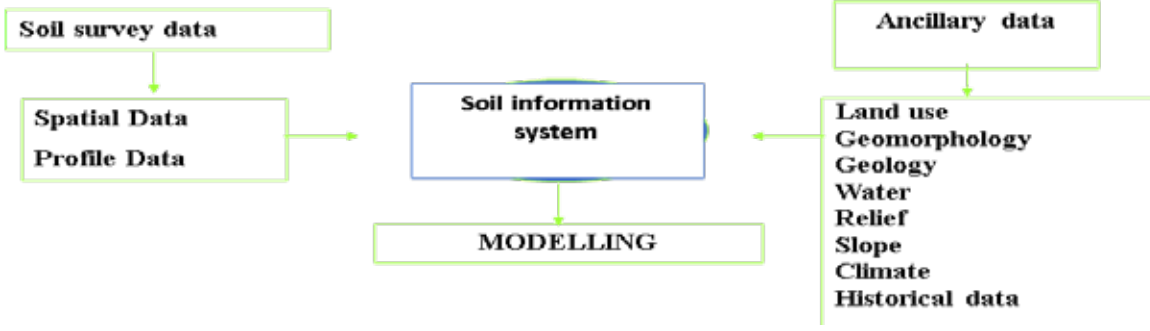
- Designed as a screening tool to provide immediate results for comparing management systems
- Monitor changes in soil quality over time
- Diagnose possible health problems due to land use and management.

SQTK characteristics

- Tests can be easily conducted on the farm by field personnel or by landowners.
- The kit allows field personnel to be an active participant with the landowner in the assessment of soil quality.
- The assessment provides the opportunity to discuss management options.

Soil information system

Soil information systems based on database obtained through RS, GIS, Ground survey and Decision support system have immense potential in Planning, management, conservation and Sustainable natural resource use.



Concept of Soil Information System

Soil information system based on database obtained through remote sensing and ground survey in combination with Geographic Information System and decision support systems can be developed. As GIS supports spatial query and display of results in the system has immense potential in planning, judicious management, conservation and sustainable use of soil, land and crop resources.

Conclusion

Soil monitoring is very important for a sustainable soil management. It involves analyzing the soil through soil tests and field observations, and seeing how the soil changes over time. Farmers can compare the results from year to year, and evaluate the effectiveness of their management. So, they can determine what changes are required to improve the soil and increase production. Knowing and understanding the soil is the key to its improvement.

20377

25. Different form of Phosphorus and Factors Affecting Them

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Introduction

Phosphorus (P) is important to plant, animal and human growth as a result of it's a key component in several physiological and biochemical processes. The properties of phosphorus square measure Atomic weight: 30.97 Delton, Density: 1.823 g/cm3, Melting point: 44.2°C and Boiling point: 280.5 °C. Phosphorus may be a naturally occurring element that exists in minerals, soil, living organisms and water. Plant growth and development need phosphorus, in massive amounts. Phosphorus is important for early root development and hastens plant maturity. The minerals that contain P are (Apatite, Rock Phosphate), these are used for manufacture of phosphatic fertilizers. It is the most constituent of energy rich compounds like ADP ATP, GTP, etc.

Phosphorus is important in DNA and RNA structures that hold and translate genetic information and then mange all living processes in plants, animals and human. Phosphorus is second most significant macronutrient in plants after nitrogen the various characteristic of P. P may be accountable limiting factors for plant growth. Mainly because of fixation of P in the soil, it is largely present in different form such as inorganic and organic forms. Generally total P found in surface soils varies from 0.005 to 0.15%, while in organic matter rich soils it is present as organic P complexes but less than 0.1% are designated as P deficient in plants.

Phosphorus mostly found in cultivated soils are fixed form than available P, a substantial a part of that has accumulated as a due to regular applications of P fertilizers. However, a large proportion of soluble inorganic phosphate added to soil is rapidly fixed as insoluble forms soon after application and becomes unavailable to the plants. In acidic soils, free oxides and hydroxides of Al and Fe fix P, while in alkaline soils it is fixed by Ca. Hence P availability in the soil to the crops is incredibly low.

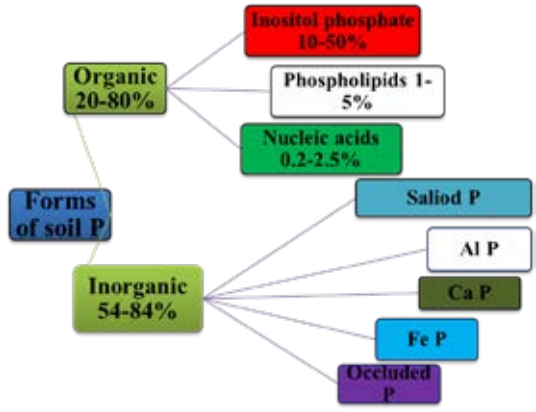

Fig.1: Forms of Soil Phosphorus

Forms of Soil Phosphorus

Organic P Forms:

The rate of organic P in soils might vary between 20% to 80% of total soil P, looking on the age of the soil, available organic matter, climate, vegetation, soil texture and land use. Most soil organic P compounds are esters of orthophosphate ($H_2PO_4^-$) including inositol phosphates (10-50%), phospholipid (1-5%) and nucleic acid (0.2-2.5%). Inositol phosphate represent a series of phosphate ester varies from monophosphate up to hexaphosphate. Inositol hexaphosphate is most common phosphate ester of total soil organic P. Most inositol phosphate and nucleic acids in soils are products of microbial degradation of plant residues, both nucleic acids, RNA and DNA, are released into soil in greater than inositol phosphates. There proportion in soil is small to total organic P, but rapidly degraded by microorganisms. The phospholipids are derivatives of glycerol and insoluble in water and readily degraded by soil microbes. Thus, phospholipid also represent small rate of total organic P. Organic P is a part of all living organisms, including microbial tissues and plant residue.

Inorganic P Forms:

All Primary nutrients found in the soils, but phosphorus has smallest quantities in solution or in readily soluble forms in minerals soils. The proportion of inorganic P in soil may vary from 54 to 84%. The soil inorganic P compounds were a dominants part of total P and is assumed to be the major compound of P to the growing plants.

Inorganic Phosphorus compounds in soils fall into one of two groups: (1) Those contain Calcium, (2) Iron and Aluminum. As a group the calcium phosphate compound become quite soluble as soil pH decrease: hence tend to dissolve and disappear from acidic soil. The calcium phosphates are more stable and insoluble at higher pH and so become dominant forms of inorganic phosphorus present in neutral to alkaline soils.

The iron and aluminum hydroxide phosphate minerals are **strengite** ($FePO_4.2H_2O$) and **variscite** ($AlPO_4.2H_2O$), have very low solubility in strongly acid soils and become more soluble as soil pH raises. These minerals are quite unstable in alkaline soil but prominent in acid soils.

Factor affecting on "Available Phosphorus"

Minerals

Adsorpation and desorption reaction are affected by the type of mineral surfaces in contact with solution. Fe/Al oxides are abundant in acid soils and have the capacity to adsorb large amount of solution P.

Soil pH

At lower pH values, more H^+ ion is available in the solution, and thus the phosphate ion species containing more hydrogen predominates. In neutral soils, HPO_4^- and $H_2PO_4^-$ are found in nearly equal amounts. Both of these species are readily available for plant uptake.

Cation and Anion Effects

Divalent cations on the CEC enhance P adsorption relative to monovalent cations. For example, clay saturated with Ca^{+2} retain greater amounts of P than those saturated with Na+ or other monovalent ions. Divalent cation increases the accessibility of + - charged edges of clay minerals to P.

Soil Organic Matter

Organic compound in soil increase P availability by:

1. Formation of organophosphate complex that are more soluble,
2. Organic anion replacement of $H_2PO_4^-$ on adsorption sites,
3. Coating of Fe/Al oxides by humus to form a protective cover and reduce P adsorption
4. Increase the quantity of organic P Mineralized to Inorganic P.

HORTICULTURE

20263

26. Production Constraints in Onion

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Onion is popular spice come vegetable crop it is having great demand in commerce. The productivity of onion is low 15.86t/ha compare to world average 20.5t/ha this is mainly due to improper production factors the following are the major constrains in onion production. Which includes from sowing of the crop to till harvest and post-harvest and marketing aspects the details of the constraints and how to defeat those problems are discussed below:

Problems Associated with Onion Production

- Lack of availability of good seeds
- Lack of good irrigation facilities
- Lack of improved varieties /hybrids
- Fail to maintain field properly
- Lack of adoption of improved technologies
- Poor storage
- Fluctuation in prices
- Attack of pest and diseases

Lack of availability of good seeds: annually approximately 10000 tonnes of onion seed is required 30- 40 per cent (Mahajan *et al.*, 2017) from public and private sector, remaining produced by the farmers without following any quality standards aspects. Like in other crops in onion also the major constraint is lack of good quality seeds because the seed production is limited only some areas and seed production is possible effectively during *rabi* season only so, it is difficult to supply the seeds throughout the year

for entire country only few farmers near to the seed producing belts may benefit and remaining will face the problem of seed shortage.

Lack of good irrigation facilities: Onion is cultivated as rainfed as well as irrigated crop especially during *kharif* season uneven distribution of rainfall may lead to stress and which intern reduces the yield and onion is one such crop where it need frequent irrigation during early stages of crop growth and atleast 10-15 irrigations during *rabi* and 4-5 irrigations during *kharif* lack of maintain ace of irrigation during these conditions also lead to yield reduction.

Lack of improved varieties or hybrids: In onion till today only few varieties performing well under different agroclimatic zones there are only few varieties showing constant performance in all the season and there is a lacuna in developing varieties resistance to pest and diseases high fluctuation in temperature. Apart from this one most important thing is no commercially important hybrids in onion till today this might be due to lack of male sterile lines and it is a time-consuming process and main hindrance in the development of hybrids is inbreeding depression.

Fail to maintain field properly: First step in the successful production is field management starting from sowing to harvesting and post-harvest handling, many farmers fail to maintain field proper spraying, weed management and irrigation management fail to apply fertilizers timely this may also reduce the yield.

Lack of adoption of innovative technologies: Many of the onion growing farmers following old method of crop production for example still they are following broadcasting method of seed this require large quantity of seeds and also costly. Use of flat beds may lead to diseases like bulb rotting against this they can use broad based furrow method this is the best method especially during *kharif* season which helps in proper drainage of water and avoid losses. By following proper spacing instead of broadcasting method farmer can improve the yield and reduce the cost of seeds. Which also helps to reduce percentage of double bulbs which is undesirable in onion production. Drip irrigation can be adopted where the scarcity of water which helps in effective water utilization.

Poor storage: In many of the cases the supply of onion is reduced by lack of storage and availability of good store, especially during kharif season due to excess rain there is a more moisture in the onion bulbs and it is not possible to cure the bulbs properly is such cases we cannot able to store onions for not more than one month this may also due to lack of suitable storage structures and improper storage practices. Improper storage also leads to post harvest losses in onion to the tune of 20 per cent.

Fluctuation in prices: Onion is one crop which is create history in the country due to is prices, like in other agricultural crops there is no minimum support price for horticulture crops, this affect the farmer economics drastically. In some cases, the farmer may get high price in some cases he sells his produce to very low cost, hence he can't predict the profit from his produce, another thing is intervention of middlemen is also one drawback where the farmer might not receive the actual price for his produce**.**

Attack of pest and diseases: The major pest and disease in onion cultivation is thrips and purple blotch from this it causes nearly 30-50 per cent yield loss. The incidence was said to be maximum during *rabi* season, where major contribution of the crop from this season if we fail to manage these biotic factors yield will be reduced drastically. Apart from these two some problems like stemphyllium blight anthracnose onion bulb mite can also reduce yield to some extent.

Way forward in improving production constraints: many institutions working on onion state agriculture university involved in improving the production constraints in onion, such improvements discussed as follows:

Conclusion: To achieve improved production we have to overcome the above discussed problems.

20279

27. Farming under Deficit Irrigation: More Gain with Less Pain

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Introduction

'More crop per drop' is the new slogan for agricultural world that has started experiencing wrath of nature in the form of change in climate, frequent and severe drought periods as well as erratic rainfall pattern. The responsibility of feeding 8 billion and counting population of our planet mainly lies on the shoulders of irrigated agriculture, which is by and large the largest consumer of available water on earth. Under such circumstances it becomes inevitable to search for non-conventional sources of irrigation such as treated waste water and devise techniques to maximize water use efficiency. Government of India launched a Centrally Sponsored Scheme on Micro Irrigation in the year 2006 to promote techniques like drip and sprinkler irrigation and encourage the farmers to use water saving and conservation technologies. However, in the past few decades, a new concept started emerging to reduce water footprints and further cut down the amount of water that goes into field when a crop is given full irrigation *i.e.* full evapotranspiration requirements and it came to be known as deficit irrigation technique. In deficit irrigation techniques, crops are deliberately allowed to undergo certain degree of water stress depending on the crop, which leads to significant reduction in amount of irrigation water accompanied with no or minor yield loss, thus increasing the water productivity. Main deficit irrigation techniques being used are regulated deficit irrigation (RDI) and partial root-zone drying (PRD). RDI involves providing irrigation less than evapotranspiration need of the crop to regulate their vegetative and reproductive growth. PRD, also known as controlled alternate partial root-zone irrigation (CAPRI) is a modified form of deficit irrigation wherein one half of root zone receives full irrigation while the other half is left unirrigated. The irrigated and dry sides are reversed and the frequency of alternating depends on crops, plant growth stages, evaporative demands and soil water content. In contrast to RDI where reduction in water use is often at the expense of yield, PRD has been found to minimize water uses to half without any significant yield loss. The concept of PRD was first utilized by Grimes on cotton in USA using alternate furrow irrigation and since then it has been modified and improvised to be used in different field and horticultural crops. PRD can be employed using different irrigation techniques such as surface and sub-surface drip irrigation and sprinkler irrigation depending on the type of crop and availability of resources.

Assumptions and Mechanism

PRD is based on the assumption that narrowing of stomatal aperture in response to a certain period of drought would lead to substantial reduction in water loss with a minor effect on photosynthesis. This is due to the existence of a nonlinear relationship between stomatal conductance and photosynthesis rate and a comparatively lower sensitivity of photosynthesis rate to decrease in turgor pressure resulting due to water stress (Taiz and Zeiger, 2006). Thus, a decrease in stomatal conductance in the initial stages of deficit irrigation reduces transpiration rate more than it affects the intercellular CO_2 concentration required for photosynthesis leading to an increase in water productivity. Second assumption is that the unirrigated part of root system can send a signal to shoots to close stomata resulting in further reduction in water loss. This signal from root to shoot could be explained as a feed-forward mechanism, wherein abscisic acid (ABA) acts as the signal of water stress originating from unirrigated side of root zone and is transported via the transpiration stream to regulate the stomatal opening and leaf expansion thus acting as a first line of defence against the anticipated drought at the point when water stress is as such not detectable in the shoots. Subsequently, with prolonged drought the older leaves may start wilting leading to subsequent increase in ABA production and the signal can be sent to younger leaves to further cut down water use.

Types of PRD

In practice, PRD can be employed in two ways, fixed or static and alternate or dynamic. In fixed or static PRD, half of the root zone receives irrigation while the other half is left unirrigated throughout the growing season. In alternate or dynamic PRD, the irrigated and unirrigated sides of root zone are alternated or reversed and this switch is guided by soil water potential or crop phenological phases along with type of crop and growing season. Alternate or dynamic PRD is considered to be more suitable for increasing water productivity because under this condition, dried half of the root zone produces enough root signals in the form of ABA while the irrigated part can maintain the soil water potential to keep the plant hydrated.

Significance of Switching Sides

Leaving the roots unirrigated throughout the growing season, as practised in fixed or static PRD may make them hydraulically insensitive and result in irreversible anatomical alterations in the roots including suberization, degradation of cortex or death of secondary roots reducing them to inert pipes of water transport with very little permeability for water and capacity to sense water stress. Hence, in order to keep "them" alive it is paramount that they receive irrigation after a certain period of drought. However, how long roots will be able to remain hydraulically sensitive and alive will depend on crop, phenological stage and evapotranspiration demand and hence, warrants a crop specific intensive research. Other PRD specific positive effect on plants include enhanced nutrient absorption capacity, better light penetration owing to reduced vegetative vigour that improves yield and quality of produce, promotion of secondary root development and improved hydraulic conductivity. Some reports also suggest that crops respond to water deficit by stimulating production of secondary metabolites of nutritional or pharmaceutical interest for example in grapes increased production of phenylpropanoids, zeaxanthin, monoterpenes was observed in response to drought which can affect grape wine flavour as well as its antioxidant value (Savoi *et al.*, 2016).

Conclusion

In view of current water status of our planet, deficit irrigation (DI) techniques could be the best approach to increase water productivity specifically in the arid and semi-arid conditions. Among different DI techniques alternate PRD is considered to be the best method as it can not only enhance water use efficiency but also sustain or even increase the yield along with improving the nutraceutical attributes of agricultural produce. Even though encouraging results are being reported for PRD in grapes, further studies will be required to attest its usefulness in drought sensitive horticultural crops with high water demand.

References

Savoi, S., Wong, D. C. J., Arapitsas, P., Miculan, M., Bucchetti, B., Peterlunger, E., *et al.*, 2016. Transcriptome and metabolite profiling reveal that prolonged drought modulates the phenylpropanoid and terpenoid pathway in white grapes (*Vitis vinifera* L.). BMC Plant Biology. 16: 67.

Taiz, L. and Zeiger, E. 2006. Plant physiology. Sinaue rAssociates, Inc., Publishers, 764p.

20304

28. Hybrid Embryo Rescue: An *In Vitro* Technique to Overcome Barriers in Fruit Crop Improvement

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Introduction

The term 'embryo rescue' refers to a number of in vitro techniques, the purpose of which is to promote the development of an immature or weak embryo into a viable plant. It involves excising the embryos from the developing ovules and aseptically culturing them in vitro until plantlet forms. In fruit crops, wide hybrids are difficult to obtain by conventional methods. Hybrids degenerate due to several pre-fertilization barriers (foreign or self-incompatible pollen may not germinate on the stigma or if germination occurs, pollen tube unable to reach the style) or post-fertilization barriers (endosperm abortion and embryo degeneration). In most of the wide crosses where fertilization does take place but the hybrid embryo aborts before maturation. Even when seeds are ready to germinate, they either fail to germinate or produce only weak seedlings which

do not survive. This is mainly due to disharmony between parental genomes resulting in embryo mortality, endosperm breakdown and seed in viability and hybrid sterility.

Technique: Embryo rescue technique nurtures the immature or weak embryo, thus providing it a chance to survive. The most widely used embryo rescue procedure is referred to as embryo culture. Depending on the organ cultured; it may be embryo, ovule or ovary culture.

Ovule culture /Ovolo embryo culture- It is a modified technique of embryo rescue through which embryo are cultured when they are inside their ovules. It prevents from damage during the excision process.

Ovary culture-This technique uses of an entire ovary into culture. It becomes necessary to excise the entire small embryo to prevent early embryo abortion.

Embryo culture- It involves isolating and growing an immature or mature zygotic embryo under aseptic condition and placing it directly in nutrient medium. In fruit plants the culture of immature embryos is used to rescue embryos prior to the embryo abortion.

Important Uses of Embryo Rescue

1. Haploid production
2. Prevention of embryo abortion in wide crosses
3. Overcoming seed dormancy
4. Shortening the breeding cycle
5. Rapid testing of seed viability
6. Inducing seedlesness
7. Disease and pest resistance

Applications in Fruit Crops

The first successful application of embryo culture technique on fruit plants was done in cherry by Turkey in 1933.

1. **Embryo rescue from interspecific crosses in apple rootstocks and kiwifruit**- Rescuing immature embryos of apple rootstocks Malus prunifolia (Marubakaido) and Malus pumila (M9) after 40–60 days of pollination and placing them into MS culture media. Resulted embryos from interspecific crosses M. pumila x M. prunifolia resulted in higher number of buds also, with the help of artificial culture media rescuing interspecific hybrids embryo in the genus Actinidia.
2. **Embryo rescue of low chilling peach hybrid and seedless grape** - An early ripening peach variety has good marketing value. The poor germination of seeds is a major obstacle in the development of early ripening peaches due to the immaturity of the zygotic embryo in hybrid seeds. Embryo rescued from fully matured embryos (85 days old) results more embryo germination percentage and take lesser days to germinate than those harvested at early stage of growth. Breeding seedless grape cultivars is an economical application of embryo rescue in grape.
3. **Embryo rescue in mango and avocado breeding**- Hybrid embryos excised from immature ovule of mango fruitlets at 6-8 weeks after pollination and inoculated in in vitro culture media and after 12-14 weeks well developed hybrid seedlings transferred for hardening. As we know that only 0.1% fruit sets in mango so this embryo rescue technology enhances our success in mango breeding also embryo rescue technique in avocado accelerates its breeding and helps to overcome the rate of immature fruit abscission.
4. **Zygotic embryo rescue in banana**- In vitro germination of zygotic embryos from open-pollinated wild seeded bananas and controlled hybridization (Bakry *et al*, 2008). Embryo is extracted and placed on a derived Murashige and Skoog semi-solid medium with BA and IAA. Cultures are incubated at 27°C in the dark until embryo germination takes place then seedlings are sub-cultured individually in tubes on a growth medium. After 2 months rooted plantlets are transferred for primary hardening to the nursery before transferring into field.
5. **Speeding up seedling development in olive breeding**- Olive having very low fruit set and also the developmental stages, seed germination, juvenile and reproductive stage are too long. So, the embryo culture technique speeding up seedling development in olive breeding programs in vitro germinated embryos having rapid development and gave rise to normal plants under greenhouse conditions. Some researchers have also reported that addition of zeatin in culture media enhances the germination capacity of embryos.
6. **Shortening of breeding cycle in papaya**- The breeding cycle of papaya is generally long and breeding method needs 7-8 generations (about 15 years) to develop a new strain/ cultivar. Papaya embryo culture shortens the breeding cycle of papaya. The periods (totaling 6–9 months) from seed harvesting to seedling rearing and from fruit setting to fruit harvesting could be shortened by approximately 3 months and successful in vitro culture of immature embryos from 65 to 95 days old fruits was observed and also noticed that ethrel treatment improved the quality of embryo.

7. **Embryo rescue in citrus for recovery of triploid hybrid and improving seedless lime quality**-Embryo rescue is an essential technique for citrus triploid hybrid recovery, triploid embryos are found in small seeds that do not germinate under greenhouse conditions. Embryo rescue is an effective way to recover triploid hybrids from 2x × 2x hybridization. Rescuing immature zygotic embryos in in vitro by controlled crossing between 'Seedless lime' and Acid lime to develop a hybrid of acid lime with resistance to citrus canker.
8. **Production of nonaploid (2n=9x) persimmon**-Production of polyploid obtained either by chromosome doubling or by the union of unreduced gametes with other unreduced gametes or with normal reduced gametes. If reduced and unreduced gametophytes were fertilized successfully, there is less chance of naturally normal embryo development due to endosperm genomic imbalance. Such embryo might be rescued successfully by in vitro culture technique. To obtain nonaploid Japanese persimmon (Diospyros kaki L.f.) by artificial hybridization, collect natural occurrence of unreduced (2n) pollen among hexaploid cultivars and sorted them from normal reduced (n) pollen. The sorted 2n pollen was crossed with a hexaploid female cultivar and the resultant embryos were rescued by in vitro culture techniques to obtain plantlets (Sugiura et al, 2000).

Conclusion

Hybrid embryo rescue technique is an important and successful non-conventional approach in fruit breeding. This technique is very much useful to rescue embryos of wide crosses and overcome the obstacle like embryo abortion, long juvenile phase, fruit drop and also to break seed dormancy. It is highly useful for intergeneric and interspecific hybrids, seedless breeding and stone fruit breeding where early ripening is the main target. However, isolation of tiny embryos without injury is a tedious process. Caution must be taken not to damage the embryos.

References

Bakry, F. (2008). Zygotic embryo rescue in bananas. Fruits, 63(2), 111-115.

Sugiura, A., Ohkuma, T., Choi, Y. A., Tao, R., & Tamura, M. (2000). Production of nonaploid (2n= 9x) Japanese persimmons (Diospyros kaki) by pollination with unreduced (2n= 6x) pollen and embryo rescue culture. Journal of the American Society for Horticultural Science, 125(5), 609-614.

20308

29. Tomato (*Solanum lycopersicum*) Cultivation in Polyhouse Condition

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Introduction

Tomato (solanum lycopersicum) is an important solanaceous group crop known to contain potato, brinjal and chilli. Sikkim is blessed with the required climates to grow tomatoes all year round. India is the 5th largest tomato producer in the world, accounting for 6.0 per cent of global production. Sharing 8.5 per cent of total vegetable production, tomatoes are India's third most important crop. FAO (1983) calculated that the average national yield to be reported 114 tones / ha. The big tomato-growing states are Orissa, Andhra Pradesh and Karnataka. In the recent years, consumption of tomatoes has been associated with prevention of several diseases (Sharoni Y and Levi Y, 2006). Tomato is regarded as the most important vegetable after onions and pepper (Fawusi, 1978).

Varieties

Hybrid varieties with indeterminate growing habit are ideal for greenhouse Agriculture. The hybrids grow to a height Of 3 m and use of vertical space in greenhouse. Some important hybrid varieties like Naveen, Sartaj, Himsona, Shreshtha, Pusa Cherry Type, BR 124 etc.

Nursery Raising

Tomato seedling is grown in 98 cells with drainage holes at the pro trays Lower. The growing media includes vermicompost + sand + cocopeat sterilized (1:1:1); Shallow 5 mm depressions are made in a single cell and treated with seed Captan (@ 0.2g/100) is sown one per seed. The newly formed seedlings are drill with solution of copper-oxychloride (@3 g/@Lit). The seedlings are from Ready to be planted within 21 days of being sown When they're 25 cm in height. Putting in tomatoes on 1000 sqm 20 g of greenhouse area sowing is required.

Bed Preparation

Soil clods are broken and soil is added Pick up it to fine tilth. 100 cm beds width and 15 cm in height leaving the footpath between the beds 50 cm.

Fertilizer Application

Organic manure well rotten at Rate: 10-15 kg per square meter bed is added and thoroughly mixed before getting fumigated. Mainly fertilisers proportion19:19:19, N: P2O5 : K2O Applied@ 7 g per sqm to the beds after growing fumigation.

Laying of Drip Line

One lateral line drip with a distance of 40 cm, having a discharge of 2 LPH is inserted on each seed row bed before planting. The distance between the drip lines are adjusted to the respective distance to plantation.

Mulching

Black or Silver mulch polyethylene 100 micron thickness (400 gauges) 1.2 Use m width to cover the planting beds and covering sheet edges by Buried in the ground. Holes 5 cm in diameter made from a sharp pipe on a mulch film on recommended spacing of crops.

Spacing

Tomato seedlings rising in size planting in two rows of spacing per bed Sizes 60 cm x 45 cm.

Transplanting

For better seedlings setup, being willing to irrigate beds to field should be required before transplantation. 20-25 days Old, vigorous & even, 25-30 cm in size tall seedlings are selected for planting.

Irrigation

Drip irrigation started 10 days after transplant. It offers drip irrigation Supply 2 to 3 liters of water per m2 /day depending on the demand for the crops and meteorological conditions.

Fertigation

Average NPK requirement for successfully cultivation of tomato crop 19:19:19.

Pruning

Tomato plants initially spaced at 60 x 45 cm to hold two branches per plant. After the first flower cluster, the main stem of tomato plants branches into two.

Training

Each division is trained independently plastic twine hanging from GI overhead wire trellis supporting system 3 m above Soil standard.

Lowering of Plants

The plants indeterminate to grow indefinitely Upwards, and lowering them periodically, to keep them at workable height needed.

Deleafing

The older leaves shaded by the Fresh development or land shifting Surface is regularly removed in order Reducing fungal infections and pest.

Harvesting

Tomatoes are harvested at colour breaker Stage. Tomato picking begins at 70 to 80 days after transplantation & until 170-180 days.

Yield

Fruit yielding tomato under polyhouse conditions 160 to about 180 t / ha and open conditions yield near about 50 to 55t/ha.

References

Y. Sharoni and Y. Levi, (2006) "Cancer prevention by dietary tomato lycopene and its molecular mechanisms," in Tomatoes, Lycopene & Human Health, A. V. Rao, Ed., pp. 111–125, Caledonian Science Press Ltd, Barcelona, Spain.

Fawusi MOA (1978). Emergence and seedling growth of Pepper as influenced by soil compaction nutrient status and moisture regime. Soc. Hortic., 9: 329-335.

FAO (1983). Food and Agriculture Organization of the United Nation. Produciton year book, p. 326.

20312

30. Perspectives of Coconut Cultivation in India

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Agriculture continues to be the basic instrument for sustainable development and poverty reduction. During 1960s and 70s, cotton, millets, rainfed pulses and oilseeds were predominant cultivated in many states of India. But labour scarcity together with affluent irrigation sources have brought a paradigm shift in the mindset of the farmers and gradually they shifted their cultivation pattern from annual crops to perennial crops. Today coconut is cultivated over an area of 2.08 million hectares in India. Coconut is a 'miracle' and 'versatile crop' as it has a wide range of geographical adaptation, unique chemical composition, good nutritional value, functional health benefits and versatile end uses.

Globally, out of 12.5 m.ha of area under coconut, close to nine m.ha is contributed by Indonesia, India and the Philippines. Coconut palms exert a profound influence on rural economy of many countries. It provides livelihood security to 64 million farm families across the globe, 12 million being Indians. India stands third in area (17 percent) under coconut and first (31 percent) in total production in the world. The productivity of coconut in India is 10,616 nuts per hectare. Undulating price chart of copra poses serious threat to coconut cultivation especially by small and marginal farmers. Hence crop diversification with nutmeg, cocoa, banana, pepper, ginger, turmeric, elephant foot yam, annual moringa, acid lime and inclusion of animal components *viz.*, goat (Telicherry breed), poultry and cows (Jersey) offer immense scope to overcome the economic risk and uncertainty existing in coconut production due to price crash.

There is largest germplasm of coconut in the world that provides diversity required for developing new varieties. Today there are 49 improved varieties in the country which include 29 high yielding selection consisting of 11 dwarfs, 18 talls and 20 hybrids. Among these, 16 varieties have been recommended for tender nut purpose, 35 for copra, 6 for dual purpose and three for ornamental purposes. Enhancing productivity through cultivation of improved varieties is one of the major strategies to make coconut farming profitable and sustainable. Long term strategy to meet the ever-increasing demand for coconut seedlings is to establish new seed gardens in different coconut growing tracts. Tissue culture offers a ray of hope towards rapid multiplication of the improved varieties. However as done for other bio inputs, ensuring a viable quality control mechanism in production of planting material is the need of the hour to block the transport of inferior seedlings in the distribution chain.

Coconut is a sensitive victim to receive the catastrophes of climate change. It is utmost necessary to focus the attention towards identification of new varieties as sources for resistance / tolerance to major pests and diseases in the era of climate change events. There exists a huge scope for coconut based agri – business in India to step up the present 8 % level to 25 %. It is essential to tap the future avenues in value addition *viz.*, neera / inflorescence sap production, extracting coconut milk, virgin coconut oil, coconut chips, activated charcoal and nata de-coco. Ball copra has great domestic market. Tiptur serves as the largest market for ball copra wherein the benchmark price of ball copra shoots to Rs.13,000 per quintal during festive seasons.

Coconut plantation is hit by several pests and diseases some of which are lethal, fatal and others debilitating in nature. Reports reveal that worldwide coconut is infested by atleast 830 insect and mite species, 173 fungi and 78 species of nematodes. Crop loss as high as 30 % to complete crop failure was reported due to major pests. Global warming and changing climate scenario spurs the attack of pests on coconut. Even in the recent past, minor pests of coconut *viz.*, Rugose Spiraling Whitefly have took the dimension of invasive pest pulling down the productivity of palms to a great extent. Root wilt caused by phytoplasma also presents great peril to coconut plantation. Other pests *viz.*, red palm weevil, rhinoceros beetle, eriophid mite, defoliators, black headed caterpillar and diseases *viz.*, leaf blight and bud rot also pull down the productivity. Hence integrated approach including the biocontrol strategies with parasitoids, predators, incursion management and strict quarantine are needed to combat invasions.

Mechanization offers immense scope in coconut production owing to the dearth of climbers for harvesting and related operations. Although an array of machineries has been designed and fabricated to ease the operations including coconut

climbing devices, coconut harvester, coconut dehusking machines, copra driers, deshelling machines, moisture meters, coconut shell remover, coconut pulveriser etc., still the road of coconut mechanization is endless and offers great opportunities for the researchers.

Cyber extension which include effective use of information and communication technology, national and international information networks, internet expert systems, multimedia learning systems and computer-based training systems are essential to improve the information access to the farmers, extension workers and scientists. Coconut is a perennial crop which mines nutrients from a limited volume of soil throughout its life period. Replenishment of nutrient pool of the soil in which the palm is cultivated is imperative on account of exploding nutritional disorders in coconut cultivation. Withdrawal of micronutrients to the palm has resulted in pencil point disorder, button shedding and nut fall in the gardens. Building up the soil organic pool and biomass carbon through residue recycling can be thought off to enhance the soil health in coconut plantations.

Major competitors for coconut export are Indonesia, Philippines and Srilanka. Clustering the coconut exporters and enhancing the incentives for export of coconut products shall encourage the exporters to a great deal, boost exports and increase the foreign exchange earnings. Tripartite linkage with scientist – farmer - businessmen in executing various development programmes and encouraging women folk in coconut farming can enhance the farm productivity.

20330

31. Impact of Climatic Conditions in Fruit Crop Production

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Climate change has emerged as a serious global environmental issue which affects all life forms. It increases greenhouse gases such as carbon dioxide, nitrous oxide, ozone, and methane that can have an impact on increased temperature, increased water demand, and increased biotic and abiotic stress. It has direct consequences for agriculture and horticulture. Low production of horticultural crops is being featured due to climate change. The developed commercial varieties of flowers, vegetables and fruits may perform poorly unpredictably due to climate aberration. Melting the ice cap in the Himalayan regions would minimize the freezing impact that many horticultural crops like Apple, Safran, Orchid, Rhododendron etc. need to bloom. Commercial development of horticultural plants that are grown in particular under open field conditions would be seriously impacted.

Impact on Fruit Crops

The severe weather events associated with hot and cold wave conditions have been reported to cause serious damage to many fruit crops. Temperature is reported to have influence on flora in perennial crops such as mango and guava. Mango has vegetative bias, and this is greater with temperature increases, thereby affecting the phrenology of flowering. In late emerging panicles, the percentage of hermaphrodite flowers was greater, coinciding with higher temperatures (Singh and Agarwal, 2016). India is the second largest fruit producer after China, with an area of 6.72 million hectares producing 82.04 million tons of fruit. A large range of fruits are grown in India, the main ones being mango, banana, orange, guava, grape, pineapple and apple. When the temperature increases, crops can grow faster and ripen sooner for example, Citrus, grapes, melons etc. Delay in the monsoon, dry rain spells and untimely dry rain spells, and premature rains during the period of water stress, supra-optimal. Temperatures during flowering and fruit production, hailstorms are among the most frequently encountered climatic conditions that citrus growers have experienced in the past decade or so. The climate is among the most frequently encountered during flowering and fruit growth, hailstorms. Temperature influences the rate of fruit growth; hence the use of bunch covers, which, however, increased the rate of growth in order to warm the fruit. In general, higher temperature (31-32°C) raises the plant maturity rate in bananas, thereby shortening the bunch growth time (Pachauri and Reisinger, 2007). Higher air temperature (> 38°C) and brighter sunlight on exposed fruits cause harm to the sunburn. High temperatures (above 38°C) and drought also cause chucking of bunches. Delay in the monsoon, dry rain spells and excessive rains during periods of water stress, super-optimal temperatures

during flowering and fruit production, hailstorms are some of the most frequently encountered climatic conditions faced by the citrus growers in the past decade or so. Climate change increases the air temperature and rainfall pattern change as a result of high temperature, soil moisture stress, or flooding / waterlogging may cause banana cultivation to suffer. In mango flooding, net CO2assimilation and stomata conductance simultaneously decreased after 2-3 days. However, flooding did not affect the capacity of leaf water, shoot extension growth, or shoot dry weight, but it decreased radial stem growth and root dry weight. The mortality ranged from 0 to 45 per cent in flooded trees. Hypertrophied lenticels have been observed on flooding trees but not on dead trees. Apple studies indicate that productivity will continue to decline up to 1500 msl at 40-50 percent due to warmer weather and lack of chilling requirements in lower elevations during winter and warmer summers resulting in the transfer of apple production to higher elevations (2700 msl). Winter snowfall has a floral influence. During spring, low fluctuating temperatures result in poor fruit setting during bloom, while warm temperatures result in floral sections becoming desiccated. Mild winter temperatures followed by warmer springs, advanced bud bursting and exposing buds to almond and apricot frost damage. Weather changes in the form of irregular precipitation, temperature increase, lesser days acting as the cooling cycle have begun to affect the mountain agricultural production systems and eventually people's food security. The survey was conducted in the Bikaner and surrounding areas immediately after the frost period in order to assess the effect of frost on the survival and severity of damage on arid fruit crops. Study revealed that the crops could be categorized into four groups viz based on severity of the damage. Substantially affected including crops such as aonla, gonad, phalsa, moringa, ber, ficus sp. It was also observed that few crops such as pomegranate were affected moderately, sapota and bael less affected and the frost did not affect crops such as date palm.

References

(1) Pachauri, R.K. and Reisinger, A. 2007. Climate change: Synthesis report contribution of working group I, II and III to the fourth assessment report of the inter-governmental panel on climate change (IPCC), Geneva, Switzerland.
(2) Singh, N.K. and Agarwal, P.K. 2016. Climate change and coconut plantations in India: Impacts and potential adaptation gains. Agricultural Systems, 11(7): 45–54.

20331

32. Peri Urban Agriculture

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Peri urban agriculture is defined as growing of crops and rearing of animals around the boundaries of cities. In other words, peri urban agriculture is the production of food in the outskirts of cities and towns. It also known as multifunctional agriculture because of its various functions like nature of conservation, hydrological balance, aesthetics and recreation. It can range from small to large scale activities, both commercial and non-commercial and involves growing of field crops, horticultural crops, forestry trees, rearing of livestock and poultry in the fringes of cities. As urbanisation is growing day by day, peri urban agriculture is one of the stabilizing ways to decrease the demand supply gap in urban areas. Peri urban agriculture is possible by using concepts such as hydroponics, aeroponics, aquaponics, indoor agriculture, vertical farming and rooftop production.

Benefits

It is helpful in the production of fresh food, reuse of urban waste, source of employment, creates recreational value. In the cities, where scarcity of land peri urban agriculture is the best way for generating income, improving food security and contributes to local economic development, poverty alleviation and the social inclusion of the urban poor and women by using their agricultural skills and shortening supply chain. Even women can do it themselves without any difficulty and after doing their household works. Peri urban agriculture helps in waste reduction and conservation of water by using waste water. It also helpful in mitigating the negative impact of pollution by reducing transportation and by creating greenbelts in surrounding of cities which resilience to climate change. It contributes to regulating temperatures and helps in carbon sequestration and carbon storage. Today in the world of stress, tension and

anxiety, it provides benefit for both mental and physical health.

Challenges

As there are many benefits of peri urban agriculture it faces some challenges also. Reuse of urban waste and waste water in Peri urban agriculture produces some unpleasant aspects including smells, noises, pollution and disease. Nutritional requirement of crops is not fulfilled because of inappropriate and excessive use of agricultural inputs which leads to loss in quality of produce. Only dwarf crop varieties are suitable to grow. Infestation of disease and pathogen may create harmful effects on health of human beings. Scarcity of natural resources as land due to high population densities is a major challenge for peri urban agriculture.

PLANT BREEDING AND GENETICS

20274

33. Barley: An Exclusive Source for the Brewing Industry

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Barley is the primary source used in the production of malt in the world. There are mainly two types of barley which are frequently used for the malting process: 6-rowed and 2-rowed. There are some quality parameters used to test the quality of barley malt like hot-water extract (HWE), kernel size fractions, kernel weight, β-glucan and protein contents, malting losses, friability, α-amylase activity, viscosity, and soluble nitrogen ratio (SNR). Moreover, fast hydration and germination are the important traits of barley for good malting quality. Brewing is the process of beer production in which the complex sugars like starch are fermented to alcohol by the action of fungi yeast. The brewing process consists nine general steps which includes malting, milling, mashing, lautering, hoping, fermentation, conditioning, filtering, and canning. Malting is defined as the controlled germination of barley grains, to ensure a given physical and biochemical change within the grain, followed by grain drying. Three steps are necessary to check out that these changes occur: (1) Steeping (14–18°C), to check good absorption of water by the grain (12% - 40%), (2) Germination (16-20°C), to enhance embryo growth, enzyme synthesis and a limited endosperm breakdown; and (3) Kilning (50-110°C), to make sure the product stability. As a result of the malting process, there is an enhancement in enzyme activity, soluble protein and breakdown of starch into simple sugars like sucrose, glucose and fructose along with development of the typical flavor and colour. Mashing is a key step in the beer production process. During mashing, enzymatic breakdown of the polysaccharides present in the malt takes place. The wort (resultant of mashing process) will then go through the lautering process (rinse off), where the grains are filtered from the sugar solution extracted during mashing. During hoping, the wort is boiled (100°C) together with hops so that it becomes free from any contamination which ultimately improves beer's flavor and stability. The wort will be cooled down and left to be aired so that the yeast will be added for the fermentation process (6-25°C) in order to ferment the sugar to ethanol and carbon dioxide to produce the beer. Later on, the beer is conditioned by lowering the temperature to (-2-0°C) in order to get rid of the harmful and unwanted particles that may affect the carbonation, aroma, and taste of the beer. After that, the beer is filtered with filters in order to free from the solid suspended particles such as hops, barley grains, yeast, etc. Finally, the beer is packaged in cans. One of the most analytical steps during packaging is to remove oxygen from the product in order to circumvent spoilage and deterioration. Different enzymes play important roles to catalyze all the involved reactions. Because the activity of the different enzymes is highly dependent on the temperature gradient, the manipulation of such variable is the key control mechanism for the mashing process.

Role of Enzymes in Malting of Barley Grain

The barley kernel contains most of the brewing enzymes such as amylases, glucanases, proteases and cellulases that are secreted when the kernel is treated with hot water. Each enzyme along with their roles in brewing will be discussed below.

Brewing Enzymes and their functions:

Enzymes	Source	Process	Function
α-amylases	Found endogenously in the barley kernel. Bacteria: *Bacillus licheniformis*, *Bacillus subtilis*	Malting, Mashing	Starch hydrolysis, improve Clarification
β-amylases	Found endogenous in the barley kernel, Wheat Kernel Bacteria: *Bacillus licheniformis*	Malting, Mashing	Starch hydrolysis, improve malting, Improve Saccharification, Increase fermentation yield
β-glucanase	Found endogenous in the barley kernel. Fungi: *Trichoderma* spp. *Orpinomyces* spp.	Malting, Mashing, Fermentation	Improve malting, Lower Viscosity, Improve Clarification, Aid in production of a clear wort
Fungal α-amylase	Fungi: *Aspergillus* sp.	Fermentation	Increase fermentation yield
Protease	Found endogenous in the barley kernel, *Pineapple latex* Fungi: *Aspergillus* sp.	Malting, Mashing, Storage	Improve malting, improve fermentation, improve clarification, improve chilling and storage quality
Amyloglucosidase	Fungi: *Aspergillus niger*	Mashing	Increase the amount of glucose in wort

Conclusion

Brewing is one of the oldest food processes done by mankind. Now a days, brewing is one of the lead food industries in the world. All of the main enzymes such as amylases, proteases, glucanase, and cellulase are crucial for the beer production process. It is now concluded that brewing is a complicated process that includes a series of steps like malting, mashing and fermentation. All these steps are very sensitive and any under or over-dose of enzymes can lead to a huge number of unwanted and undesirable effects in brewing.

20289

34. Metagenomics Applications for Sustainability of Agriculture and Environment

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As microorganisms existing on earth are more ancient than cultivated and domesticated crop species. Microorganisms have evolved and are still coevolving with agriculture. Our knowledge about microbes remain limited about microbes in symbiotic association with crop plant or as source of biofertilizers, but many other microbial species still remained untapped and unexplored. Metagenomics is study of all available genome in environment derived from environmental sample hence it is also referred as environmental genomics. Recent advancements in field of sequencing technologies and bioinformatics tools offers advantage of studying all microbial ecology at genetic levels. It differs from conventional microbial genomics which is based on clonal cultures and limit scope of microbial species which could be handle on culture media. Metagenomics have broaden scope by studying even those microbial species in biosphere which were nor discovered earlier or cultured in lab.

Microbiota is integral component of any ecosystem hence it is essential to deal with its functional characterization and dynamic interactions for maintaining sustainability of environment, ecosystem and agriculture. It provides us opportunity of simultaneous study of many genomes in communal ecology and genes which function collectively. It helps us to gain knowledge of microbial world which was not cultured earlier, their synergistic and antagonistic interactions. Genomic library is created from DNA extracted from of mixed sample of all microbes of particular area. It overcomes limitations of

traditional microbial culture techniques and it leads to discovery of new useful biomolecule and novel genes.

Sustainable development in agriculture obligated us to do farming activities in such way that we can meet society's need of food without any compromise in the ability of present as well as future generation to meet their own needs. This can be achieved by following sustainable farming practices, saving water, maintaining soil quality, preventing soil erosion and conserving agro biodiversity. Various scientific innovations are coming up now days for producing healthy food without damaging soil health. Simultaneously maintaining sustainability of environmental resources for future generations is equally important. Protecting soil health, species diversity and balance of ecosystem are major component for the same. Soil microbes have influence on edaphic properties, so understanding microbial diversity in soil by soil met genomics study is more important in agriculture. It includes isolating soil DNA and production and screening of clone libraries. Success of such study is determined by efficiency of following steps-

1. Isolating high quality DNA- either by direct method of cell lysis or indirect method of recovering cell followed by its lysis.
2. Creating met genome libraries- Using different vectors like plasmids, cosmids, BAC
3. Perform sequence analysis- it is done at two levels
   a) Sequence based approach- it includes analysis based on conserved DNA sequences, hybridization probe or PCR primer of known gene, comparative sequencing etc.
   b) Function based approach- screening clones for expression of desirable traits. (Gupta *et al.*, 2018).

Several methods of studying microbial soil microbial diversity have been reported (Sabale *et al.*, 2019) which can be described as follow-

Culture dependent method-a). Plate count method b). Community level physiology profiling.

Culture independent methods-

- Sequencing based methods- clone library sequence, amplicon sequence and shotgun sequence.
- PCR based methods- RFLP, RAPD, T-RFLP, qPCR, microsatellite region-based characterization etc.
- Non-PCR based method- DNA reassociation, Guanine+Cytosine content of DNA, Reverse sample genome probing.
- Microbial lipid-based techniques- Grouping microbial taxonomy based on their fatty acid profile.
- **Applications of Studying Microbial Diversity with Met genomics-** It can contribute to environment, agriculture, biotechnology and therapeutic sciences in following ways:
- In agriculture there are different mechanisms of microbial association with crop plants which triggers growth, symbiotic nutrient uptake, stress tolerance response and defense response can be very well understood by metagenomic studies and agricultural important microbes can be used for sustainable agricultural practices.
- It is now possible to study soil habitat specific microbes, their space and time dynamics, possibilities of horizontal gene transfer
- Soil metagenomics study allow us to study soil microbial species variability, their functional genes, identify any biocatalyst for its industrial application.
- Microbes secreting various enzymes like β-glucosidase, Chitinase, Arylsulphatases, Phosphatases are important for maintainance of soil health as well as nutrients availability to crops.
- Metagenome studies of microbes which are important source of several bioactive compounds like cellulases, lipases, xylanase, amylase, pectinase, endocellulase are gaining recognition for industrial applications.
- Metagenome approach permit discovery of various antibiotics like Turbomycin, Beta-lactamases, Fasamycin A and B, Indirubin, Terragine as well as novel clones of *E coli* showing resistant to tetracycline, kanamycin, rifampicin, streptomycin etc.
- Microbes capable of degradation of harmful waste either in soil or water sources are extremely important for controlling soil and water pollution.
- Rhizospheric microbes as source of biosurfactant can have wide applications in pesticide industries and biofilm production and molecular biology lab chemicals.
- Metagenome studies combined with omics approaches provides way forward to Rhizosphere engineering for sustainable plant ecosystem.
- Metagenome studies also help in solving mystery of evolutionary biology and phylogeny analysis based on mitochondrial and chloroplast genomes which are supposed to be contributed by extinct prokaryotic species.
- Microbes participating in regulation biogeochemical cycling of carbon, nitrogen, oxygen, water and phosphorus cycle are major support of environment, soil and

ocean ecosystems can be studied well in metagenomics.

- Apart from beneficial effect on soil and plants, metagenomics study is also useful in pharmacy and medicinal sciences by studying human gut microbiome, precise and personalized medication is possible.

References

Gupta, N., Vats, S., & Bhargava, P. (2018). Sustainable agriculture: role of metagenomics and metabolomics in exploring the soil microbiota. In *Silico Approach for Sustainable Agriculture* (pp. 183-199). Springer, Singapore.

Sabale, S. N., Suryawanshi, P. P., & Krishnaraj, P. U. (2019). Soil Metagenomics: Concepts and Applications. In *Metagenomics-Basics, Methods and Applications*. IntechOpen.

20290

35. Plant Breeding Technology is a Future of Agriculture

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Introduction

Plant-Breeding and other agricultural technologies have contributed considerably to hunger reduction during the last few decades. There was need to develop new approaches to improve the quality and quantity of yield. As the world's population is rising increasingly and alarmingly, new methods for better growth, improved nutrient quality, and disease-resistant crops were introduced. From the outset, man has been trying to manipulate various ideas and techniques to save crops from various diseases using conventional methods. Unfortunately, conventional methods are no more serviceable towards the current needs. Although, from past five decades global food grain production is growing as with increasing population but still 1 billion persons of the world are malnourished because of food insecurity. It has been estimated that worldwide food production must be increased by 70% by the year 2050 to fulfill the need of expanding population and growing consumption of food. New Plant-Breeding Techniques (NBTs) are methods allowing the development of new plant varieties with desired traits, by modifying the DNA of the seeds and plant cells. They are called 'new' because these techniques were developed only in the last decade and have evolved rapidly over the last few years.

Techniques at the DNA Level

1. Gene transfer for the production of transgenic species - The genetic construct is transferred to the nucleus and incorporated into the DNA of the plant. It can be done by direct or indirect methods. An example of this is the Bt gene, which has been transferred from the bacterium Bacillus thuringiensis to maize, cotton, soybeans, etc. to protect plants from insect damage. Both cytoplasmic male sterility (mitochondria) and herbicide class triazine resistance (chloroplast) have been transferred via cybrid formation to a single Brassica line (Pelletier *et al.*, 1983).

Bt cotton – Its key benefit is the reduction of insecticide usage in the production of Bt cotton, where bollworms are major pests. Increases the yield of cotton due to the successful management of bollworms by the ecological benefits that flow from it. Our country has developed Bt cotton varieties. IPAU Bt 1, F1861 and RS 2013, this is a cheaper alternative to Bt hybrid cotton seed. In India and China, in particular, the area under Bt cotton has increased sharply over the last couple of years, reaching 25 million acres in 2007 (James, 2007).

Golden rice- It is a variety of rice (Oryza sativa) produced by genetic engineering to biosynthesize beta-carotene, a precursor to vitamins. They combined the phytoene synthase gene from maize with the original golden rice crt1. Golden rice 2 produces 23 times more carotenoids than gold rice (up to 37 μg / g). In contrast to the ongoing complementing and fortification programs, the Golden Rice Project claims to be a sustainable project against a different view. (Potrykus, 2001).

Cisgenesis /intagenesis-It refers to the introduction of a fragment of DNA into a plant that is derived from the same or closely related species in order to transfer useful genes. Example-The transfer of unfavorable genes located on the same chromosome (linking drag) can also be avoided. This is used to great advantage in crops such as apples and potatoes.

Plastid transformation- Transmission

of foreign DNA into plastids (chloroplastic or mitochondrial DNA). The high level of gene expression is due to a large number of gene copies. To date, this method has only been successfully used in the manufacture of bioplastics in tobacco.

Site-directed mutagenesis triggered by zinc-finger nucleases (ZFNs)- These are synthetic proteins containing zinc-finger domains that bind to a specific DNA triplet and nucleases that can bind to a DNA double helix. Technology use of QQR Stimulates Mutations in its Recognition Sequence in Arabidopsis Cells. Examples of ZFN techniques include Meganuclease (MN), Transcription Activator-Like Effect Nucleases (TALENs) and Clustered Frequently Interspersed Short Palindromic Repeat (CRISPR).

Site-directed mutagenesis via oligonucleotides -the transfer of a specific DNA sequence to allow the selective modification of DNA in a particular segment of the gene. A short-synthesized DNA or RNA sequence of 20 to 100 bases (oligonucleotide) is transferred to a cell (*e.g.* electroporation, polyethylene glycol (PEG) protoplast therapy or particle bombardment)., it including PCR, cloning, sequencing, and gene detection.

Gene silencing – RNA interference (RNAi)- RNA interference (RNAi) produced transgenic plants capable of switching off endogenous genes and invasive nucleic acids. The potential role of RACK1 in drought stress in rice cultivation has been explained. Crown gall-resistant apple tree roots were obtained by transformation with transgenes designed to express double-stranded RNA from iaaM and ipt genes.

Reverse breeding-- The technique attempts to reproduce genetically identical offspring from a selected heterozygous plant with all desired positive characteristics. This was only possible with vegetatively propagated genotypes.

Transformation via mini-chromosomes- it can be used as artificial chromosome platforms for genetic engineering

Synthetic biology-Individual elements, such as nucleotides or amino acids, are reassembled or synthesized without a natural precursor e. g. Integrating the Bt gene from the bacterium into the genome of maize.

Techniques at the Plant Level

1. **Phenotypic selection in the field** - Phenotypic selection of single plants is subject to significant prediction errors, as the genotypic effects are obscured by environmental effects. From the point of view of organic farming, the relationship of the plant with the soil and the climatic conditions is a prerequisite for the production of locally adapted crops.
2. **Shuttle breeding** - -Changing the environment during the selection process is an attempt to increase the adaptability of the varieties by alternatively testing the breeding material at two or more different locations. In addition to promoting adaptation to abiotic stress factors such as heat, frost, drought, waterlogging, salinisation, acidification, etc., this method is also used to improve resistance to various pests and diseases.
3. **Change of sowing time** - Changing the sowing time (early or late spring, early or late autumn) is typically carried out with the intention of selecting parameters such as day length insensitivity, lower demand for flower formation or yield and quality consistency at different growing times.
4. **Ear-bed method** - The location of the plants in the seedbed (ear-bed) represents the original arrangement of the ear spikelets, which grew at different levels. This method was developed by biodynamic growers, especially for cereals, to increase the efficiency of the selection process.
5. **Test crosses -** For plant breeding and cross-breeding plants, Test crosses play a especially important role in cross-pollinated crops such as maize, rye and forage grass and plant breeding.
6. **Phenotypic selection under controlled conditions**- Individual traits, for which only one gene is normally responsible, such as brown rust resistance in wheat, may be assessed in the greenhouse or climate chamber at the seedling stage.
7. **Analytical / technical selection** - Most phenotype-based characteristics or technical features can not be identified. Various tests have to be performed in the laboratory to identify these features. For example, to make predictions for baking efficiency, the quality of wheat is examined through several fast assessments. Another test looks at the glucosinolate content of broccoli that is determined to evaluate its anti-carcinogenic potential.
8. **Organoleptic selection –** Goods include determining the consumer ‘s understanding of looks, smells and tastes. For this reason, blind experiments are conducted according to a specific experimental design with new varieties of interest.

References

James, C. (2007). *Global status of commercialized biotech/GM crops: 2007* (ISAAA Brief No. 37). Ithaca, NY: International Service for the Acquisition of Agri-Biotech Applications.

Potrykus, Ingo. "Golden Rice and Beyond" *Plant Physiol*, 125(3): 1157-1161. March 2001.

Pelletier, G., C. Primard, F. Vedel, and P. Chetrit. 1983. Intergeneric cytoplasmic hybridization in Cruciferae by protoplast fusion. *Mol. Gen. Genet*. 191:244–250.

20307

36. Marker-Assisted Germplasm Evaluation (MAGE)

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Marker-assisted germplasm evaluation (MAGE) aims to complement phenotypic evaluation by helping to define the genetic architecture of germplasm resources and by identifying and managing germplasm that contains alleles associated with traits of economic importance. Molecular markers may allow for characterization based on genes, genotypes and genomes which provides more precise information than classical phenotypic or passport data. Molecular marker data can be used to answer questions of identity, duplication, genetic diversity, contamination and integrity of regeneration. In addition, molecular markers are extremely powerful for identifying zygosity at important loci in species which are vegetatively propagated such as potato, sugarcane, taro and sweet potato. Many features revealed by molecular markers, such as unique alleles, allele frequency and heterozygosity, mirror the genetic structure of germplasm resources at the molecular level. On a more fundamental level, molecular marker information can lead to the identification of useful genes contained in collections and aid in the transfer of these genes into well-adapted cultivars. MAGE can play an important role in the procedures related to the acquisition/distribution, maintenance and use of germplasm. It can be summarized that molecular markers can be used for: (i) differentiating cultivars and constructing heterotic groups; (ii) identifying germplasm redundancy, underrepresented alleles and genetic gaps in current collections; (iii) monitoring genetic shifts that occur during germplasm storage, regeneration, domestication and breeding; (iv) screening germplasm for novel genes or superior alleles; and (v) constructing a representative subset or core collection.

The realization of the importance of MAGE led to the formation of the Generation Challenge Programme (GCP). The GCP aims to utilize molecular tools and comparative biology to explore and exploit the genetic diversity housed in existing germplasm collections with a particular focus on improving the drought tolerance of various cereals, legumes and clonal food crops. One of the primary goals of the GCP is the extensive genomic characterization of global crop-related genetic resources (composite collections); initially using SSR markers to determine population structure and now moving on to whole genome scans (including SNP and diversity array technology (DArT) arrays) and functional genomics analysis of subsets of germplasm (mini-composite collections). Thus, the GCP has created composite collections covering global diversity for most of the 20 CGIAR mandated crops. These consists of up to 3000 accessions or no more than 10% of the total number of available accessions for inbreeding crops and 1500 accessions for outcrossing species (where each accession must be treated as a population). It is expected that this analysis will also lead to the development of genetically broad-based mapping and breeding populations. The results from these GCP-supported projects are already starting to be made available for the benefit of the scientific community. Furthermore, the GCP is supporting a project on allele diversity at orthologous candidate (ADOC) genes that will produce and deliver a public data set of allelic diversity at orthologous candidate genes across eight important GCP crops and assess whole sequence polymorphism in a DNA bank of 300 reference accessions for each crop. This reference germplasm which has already undergone one level of genome scan, will be evaluated for traits associated with drought tolerance to test for associations between observed polymorphisms and trait variability.

Molecular markers can be used for germplasm management in different ways. Markers with known functional alleles or associated with agronomic traits can be used to trace, select and manage these alleles or traits. Genetic markers that reveal multiple bands or represent multiple loci such as RAPD or amplified fragment length polymorphism (AFLP), are usually difficult to trace back to specific alleles/loci, so they need to be converted into markers that are locus-specific, such as sequence tagged sites (STSs), SSRs or SNPs. Neutral markers or markers in unknown chromosomal regions can be used for fingerprinting

and background examination. In this case any type of marker that detects a high rate of polymorphism is useful as long as it is able to reveal genome-wide polymorphism.

An efficient MAGE system consists of several key components. MAGE largely depends on multivariate analysis of DNA genotypes. There are several questions that need to be answered for each experiment: Which entities should be sampled? What is the nature of the genetic material to be sampled? How should heterogeneous, segregating populations be sampled? What types of variables should be measured? How many variables (*e.g.* markers) should be measured? Should analyses be carried out on raw multivariate data or derived genetic similarities? Among these questions, the most frequent might be how many markers are enough for a genome wide MAGE; the answer however, depends on the questions that MAGE is expected to answer, and it also depends on the type of marker being used. As a rough estimation, the number of markers that are needed to detect linkage disequilibrium between any two markers in the genome can be used to judge how many markers are needed for a genome-wide MAGE, which is apparently crop-dependent and also higher than in most MAGE projects that have been reported if genome-wide germplasm is evaluated within closely related germplasm or populations at gene or sequence level. With the development of SNP markers covering whole genomes and high-throughput array-based genotyping systems, using markers developed from all candidate genes for all available germplasm collections can be a realistic target in the near future.

20314

37. Quinoa: An Alternative Crop for Semi-Arid Regions

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Chenopodium quinoa is an annual gynomonoecious plant with basic chromosome number x=9. It is an allotetraploid plant with 2n=4x=36. It is native of Andeis region of America. Quinoa was main food for pre-Hispanic communities of the Andean Region, grown for over 7000 years mainly in the current locations of Peru, Bolivia, Ecuador, Chile, Argentina and Colombia, from 2° North latitude (Colombia) to 47° South latitude (Chile). Quinoa signifies cultural heritage in many Latin-American countries. It has survived from extinction in different agro-ecological regions, ranging from the extremely dry Altiplano highlands at 4000 m above sea level with annual precipitation of 150 mm to coastal zones of central and southern Chile, where soils are clayish and rainfall is above 1000 mm/year. It is distributed throughout the central and north-central Andean valleys and southwards into the Araucanian coastal region and adjacent Patagonia. Crop is mainly cultivated in Bolivia, Peru, and Ecuador. Quinoa diversity is described by five major ecotypes associated with the geographical region: Altiplano (Peru and Bolivia), Inter-Andean valleys (Bolivia, Colombia, Ecuador and Peru), Salt lands (Bolivia, Chile and Argentina), Yunga (Peru, Bolivia and Argentina) and Coastal (Chile). The fruit achene is an excellently balanced source of nutrients like carbohydrates, lipids and protein. The fruit offers an ideal balance of all the 20 essential amino acids.

There is a great concern raised for this crop in developing world since it is considered as one of the most important crops in food security, but limited research exists on the aspects of genetics and plant breeding for genetic improvement of quinoa cultivars. Cultivated quinoa exhibits a vast genetic diversity, in terms of plant coloration, flowers, protein content, seeds, saponin content and leaves calcium oxalates content, which allows quinoa to adapt a wide range of climatic conditions. There are about more than 6000 varieties of quinoa cultivated by farmers around the world. Due to the diverse plant genetic resources of quinoa, the opportunities for adaptation to many abiotic stresses have significantly increased the interest of quinoa cultivation. The crop unveils vast adaptability to diverse environments, including the harsh conditions that characterize much of the Andean zone. Thus, the production has spread through many different countries, including Japan, Australia, Spain, Germany, England, Sweden, Denmark, Netherlands, Italy, France, Finland, Kenya, Ethiopia, India, the USA, Canada, among others. Several studies suggest that quinoa is an interesting alternative crop for the use of depreciated and deprived soils and it has been successfully verified in various countries in Asia, the Near East and North Africa. In fact, the

enormous plasticity of quinoa includes tolerance to frost, salinity and drought, it has the ability to grow on marginal and arid soils and is also adapted to high altitudes. The strong tolerance to drought and salinity allows it to resist the current and future challenges of the global climate change, including water scarcities. The plant adapts well to climates ranging from desert dry weather to relative humidity from 40 to 88%, with temperatures from −4°C to 38°C. Several genotypes of quinoa are able to maintain a high photosynthetic efficiency under water deficit conditions and to quickly re-establish photosynthesis after a period of rehydration. Quinoa shows an extraordinary physiology of adaptation to stress, particularly for water use efficiency. Martinez reported 500 L water per kilogram quinoa, a significantly lower water-use footprint compared with rice (2497 L/kg) or maize (1222 L/kg), figures that are even greater if one considers also quantity of protein per kilogram. Quinoa production can be practiced with an annual precipitation of 100–200 mm. The drought tolerance of quinoa has been attributed to a reduction in leaf area the presence of calcium oxalate vesicles in leaves, which could reduce the transpiration rate and their branched and dense root system, which is able to penetrate into 1.5 m sandy soil.

The growth and production of quinoa are not necessarily restricted to the Andean mountains. Quinoa may have potential in other mountainous regions in the developing world, such as the Himalayas and the central mountain region of Africa. Besides, quinoa has been mentioned as a potential new crop for NASA's controlled ecological life support system (CELSS), which utilizes plants to remove carbon dioxide from the atmosphere and to generate food, oxygen, and water for the crew of space missions.

Future of Quinoa

Quinoa is considered a multipurpose agro-industrial crop. The seed may be utilized for human food and in flour products and animal feedstock due to high nutritive value. Uniform starch granules of quinoa have many industrial applications. Some of the likely industrial products of quinoa are flow improvers, fillers in the plastic industry, anti-offset, dusting powders, and complimentary protein for improving the amino acid balance of human and animal foods. Saponins may be exciting as potential insecticides, antibiotics, and fungicides, and to the pharmaceutical industry as a mediator of intestinal permeability, which could help in the absorption of specific drugs, and for reducing the level of cholesterol.

Plant features of quinoa are valuable for the adaptations to other growing regions of the world. Further, breeding of quinoa in new provinces should focus on uniformity, early maturity, high yield, quality traits, and industrial applications of the seed and of specific ingredients. Quinoa also may be used as a break crop in crop rotations, because it is not susceptible to cereal diseases, and only a little susceptible to soil-borne nematodes. Since considerable genetic variation present is among cultivars for many of the traits, it should be possible through selection and breeding to combine many of the desired traits in single cultivars, which in turn, could establish quinoa as a novel crop for agriculture in other parts of the world.

20316

38. *Bt* Crops: Worthful or Hazardous...?

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Bt crops, still being the burning issue, has been raising the tremendous controversies all over the world thrashing the agriculture in the vortex of the chaos. The chaotic uproar has grabbed a peak that has pressurized the grand decisive powers of all from the excogitative scientists up to the almighty governments of different countries in the world. *Bt*, a tool developed to control the hazardous pest attacks on different crops has been widely accepted in one form as spore-based formulations of the bacterium as organic applications while in other form as engineered genes transforming the genome of crops, it has been greatly abandoned. Deliberate discussions have been and are being constituted searching for the reasons of such an ambiguous momentum of this technique, a bit quantum of which is laid here.

What are *Bt*-Crops?

Bt stands for *Bacillus thuringiensis* which is a Gram-

positive, soil-dwelling bacterium, commonly used as a biological pesticide. The insecticidal property is conferred on it by the cry genes encoding the crystal-shaped proteins called Cry δ-endotoxins formed during sporulation, which after entering into the alkaline digestive tracts of certain feeding insect orders get solubilized by proteases liberating the toxin from the crystal and further get inserted into the insect gut cell membrane forming pores and paralyzing it due to which insect stops eating and starves to death. *Bt* crops are the genotypes of crops that have been genetically modified (GM) by genetically engineering these cry genes into the whole plant genomes making them resistant to certain insect orders. In addition to δ-endotoxins (Cry and Cyt toxins), *Bt* also produces a novel family of insecticidal proteins *viz*. vegetative insecticidal proteins (Vip) during its vegetative stage.

Bacillus thuringiensis was first isolated in 1901 by a Japanese biologist, Shigetane Ishiwatari, who was investigating the *sotto* disease in silk worms. After knowing *Bt*'s apparent effectiveness against caterpillars in 1920, soon from 1928 it started to be used against crop pests in the form of spore-based formulations and continued upto the 1980s. But the first transgenic approach employing the engineered *Bt* genes to derive genetically modified (GM) Hornworm-resistant tobacco plants was successfully attempted in 1987 by a company *viz*. 'Plant Genetic Systems' in Belgium. Commercialization of *Bt* crops started in 1996 with the introduction of 'Bollgard' cotton in the USA and was followed by *Bt* maize and *Bt* potato.

In India, the Environment Protection Act was passed in 1986, under which the Genetic Engineering Approval Committee (GEAC) was constituted in 1989, to examine and give clearance to genetically modified organisms (GMOs). As per its first permit granted in 1994, M/s Pro Agro Ltd conducted transgenic rapeseed field experiments in 1995 whereas field testing of firstly introduced insect-resistant plants *i.e. Bt* tomato and *Bt* cotton were started in 1996. In 2002, three hybrids of *Bt* cotton were released for cultivation in India. The indigenous varieties of *Bt* cotton has been remained quite popular since before and has progressed a rapid further development with stacking of more genes imparting increased level of resistance to different insects from which a country like China also couldn't stay apart. A number of other *Bt* crops have been developed in the country *viz*. tomato, potato, tobacco, cauliflower, okra, rice, sorghum, groundnut, sunflower and castor with some being in different stages of confined field trials but the issue has raised the dramatic uproar when the *Bt* brinjal, the first genetically modified food crop in India was on its first launch to be in the commercial market circumvolving all the GMOs in the controversial whirl. At present moment all the GM food crops have been banned in India. On the other side four varieties of *Bt* brinjal have got permitted in Bangladesh since 2014 which according to them have been dealing good with their brinjal production. The other countries cultivating *Bt* crops are Australia, Mexico, Philippines, South Africa and many European countries including Spain, the Czech Republic, Romania, Portugal, Germany, Poland, Slovakia, etc covering more than one billion acres of cultivated area in the world.

Safety of *Bt* Crops

Bt crops, since beginning, have been and further will be being undergone the extensive investigation for their safety for use as a food and potential unintended impacts on the environment through various angles few of which could be as follows.

Human dietary risk assessment

Concerning the safety of *Bt* crops for human consumption, rigorous testings are performed including acute oral toxicity test, assessment of the allergenicity, feeding studies on animals such as mouse, rabbits, fish, chicken, goats and cows, and also field trials conducted at different locations. But the results have generated divergent opinions about their veracity. Some agencies like Environmental Protection Agency (EPA) of USA, private seed companies like Monsanto, Mahyco declares them as the safest asserting on the basis of the long-term testing experiments they have carried of their own. Whereas some other scientists deny the same pointing out many inadequacies in the tests conducted, lack of clear cut parameters for monitoring the tests, presenting insufficient data for thorough review, lack of details of the testing methods followed, lack of validation of the tests by an independent and reliable organization and so on further putting that the data made available also has some flaws. The concerns were intensely raised up in India in case of Mahyco developed *Bt* brinjal, the India's first vegetable/ food biotech crop in collaboration with Tamil Nadu Agricultural University (TNAU), Coimbatore and University of Agricultural Sciences, Dharwad. A French scientist notable for his anti-GM perspective, Professor Gilles-Eric Seralini of the Committee for Independent Research and Information on Genetic Engineering (CRIIGEN), after commissioned by Greenpeace India, assessed firstly and independently the Monsanto-Mahyco's dossier on toxicity tests submitted to the Indian regulatory authorities. He dogmatized the statistically significant differences on the health of animals fed GM and non-GM brinjal in the raw experimental data, which were discounted in

submitted dossier summaries. He, based on his key findings, reported a number of health problems in GM brinjal fed animals *viz*. induced antibiotic resistance; less calories with different alkaloid content and more insecticide toxin affecting the blood chemistry, blood prothrombin, blood total bilirubin (liver health), and alkaline phosphate in goats and rabbits. He also found increased weight gain, roughage intake, milk production in lactating cows as if were treated by a hormone whereas in rats diarrhoea, increased water consumption, decreased liver weight and also modified feed intake in broiler chickens. He further aware about the potential risk of long-term effects of developing cancers or tumours which could not be assessed in the still ever longest toxicity test of 90 days suggesting to call for further investigation.

Further the fusion product of more stacked genes differing in their amino acid content *e.g*. Cry1Ab-Cry1Ac in brinjal rather than single Cry1Ac protein derived from bacteria used in tests may be different in conformations. According to the study in Australia in 2005 on GM peas (*Pisum sativum)* developed by the Commonwealth Scientific and Industrial Research Organization (CSIRO), glycosylation pattern of protein also changes from crop to crop due to which transgenic peas having a transgene for the enzyme alpha-amylase inhibitor-1 (α - AI1) from the common bean (*Phaseolus vulgaris*), succeeded in conferring 99.5% resistance against the pea weevil as similar in bean but failed the immunogenicity tests in mice and ultimately could not be commercialized.

Also, the approval former made by GEAC in India for commercialization of the GM crops has been questioned regarding the norms, standards, procedures and criteria for what constitutes a safe product suggesting their reconsideration and its ambiguousness is imputed on some kind of conflict of interest of its few experts doubting its unbiasedness in assessment. Expert committees EC-I and EC-II set up to examine biosafety of *Bt* brinjal supported its benefits outweighing the perceived risks but some scientists feel that the number of animals tested and the time period for which the tests were conducted are inadequate.

Another aspects of dissatisfaction against GM crops are gene transfer to other organisms such as gut microflora and development of antibiotic resistance in these organisms, lack of sufficient study on the digestibility of the *Bt* protein and the products formed after digestion.

Impacts on the environment

Environmental safety of *Bt* crops has always been criticized and questioned regarding the numerous aspects.

The impacts on environment stating the **ecological risks to natural ecosystems including the non-target organisms** are of a huge concern. The non-target lepidopterans such as butterflies and moths bear the high risk of which a renowned example reported in the late 1990s is of the Monarch butterfly larvae that are in danger of toxicity due to the exposure to high levels of *Bt* pollen from *Bt* corn. Though it is shown that the *Bt* toxin density in *Bt* corn pollen is not enough to cause any harm to the insect larvae, some criticize that the studies of a few species of non-target organisms are insufficient to guess the possible harm to complicated ecosystems and the food chain as a whole. The cause of a phenomenon called Colony Collapse disorder (CCD) in bee hives is also offered up to the GM crops especially *Bt* corn as some German researchers observed a possible correlation between exposure to *Bt* pollen and compromised immunity to Nosema but it was found non-coherent as its occurrence observed even in the countries positing ban on GM crops like Switzerland and speculated to have exacerbating causes.

A **threat of extinguishing crop local landrace biodiversity** can be imposed by the *Bt* crop varieties both due to their economical preference by farmers in controlling the insects as well as the invasive dominance and further unintentional gene flow in natural ecosystems on behalf of the fitness advantage conferred on them by the *Bt* genes. Some pro-GM scientists' question about whether green revolution has dispelled local tall varieties from general cultivation or not while others assert on restricting such contamination due to the unintentional gene transfer.

Another major concern about the *Bt* crops is the ***Bt* resistance development in insects** to more and more stacked *Bt* genes due to their long run use. The development of second generation *Bt* cotton by Monsanto after breakdown of resistance by pink bollworm in first generation bearing only one *Bt* gene *viz*. *cry1Ac* is the ascendancy of this process. Some other examples of such resistance development are in Indian mealmoth, cabbage looper, etc. Though this is the problem also of chemical pesticides, their dose could be increased or decreased accordingly which could not be the case in genetical modification. In such breakdown of resistance, farmers have to rely on expectations that new varieties with more stacked genes would soon be developed and solve the problem. But nearly all the scientists take this concern as granted because resistance itself is not a new phenomenon and is a very obvious natural consequence to evolve mechanisms to evade the effects of the older ones which could be delayed or almost ceased by one or the other ways *e.g*. pyramiding genes of multiple resistance in plants acting on different sites of the

pests, crop rotation strategies or planting *Bt* seeds along with non-*Bt* ones in a certain proportion benefitting dually by escaping total crop from the pest attack due to availability of another host plants and also allowing natural enemies of pests to survive.

But an alongside problem of **resurgence of secondary pests** is inevitable and has been found to erode the benefits of *Bt* crops due to the reduction in use of pesticides. Although the number of insecticide spray applications controlling bollworm in cotton reduced drastically, the surge of sucking pests population such as mealy bugs and aphids in India and of mirids in China which are not affected by *Bt* toxins went beyond the control which upon called forth the need of sprayings to control the emerging secondary pests. While one side is convincingly asserting how much the increased insecticide use for control of the secondary pests is lower than that the reduced one for control of target lepidopteran pests as bollworm, other side remonstrate the practicality of significant lower reduction in pesticide use than that actually reported one.

Further, the **Persistence of *Bt* genes in environment** is yet another matter of concern and studies in this prospect has also forked the perceptions. Their accumulation in soil rather than other habitats with impact on soil microflora is admitted by many of the scientists. Some studies give the persistence period of over 200 days, with half-lives between 1.6 and 22 days, admitting their initial rapid degradation by microorganisms, as well as adsorption on organic matter and longer residual effect while some, in contrast, deny their persistence even in the soil demanding the requirement of more investigation.

Terminator technology, corporatization and impacts on the farmers

By employing Genetic Use Restriction Technology (GURT), also called as terminator technology, multinational seed/agrochemical industries genetically engineer plants to produce sterile seeds at harvest to compel the farmers to buy seeds each season and lose their independence with the seeds. Such corporatization flourishing the monopoly of few companies in the market and collapsing the farmers' economy is also impugned by many scientists. In response, pro-GM scientists toss the point saying this would be the case with all the popular high yielding hybrids that compensates the initial cost investment of farmers on seeds further assuring about the development also of the varieties with reusable seeds from the previous harvest of the crop as in the case of *Bt* brinjal, the open-pollinated cultivars developed by Tamil Nadu Agricultural University (TNAU) and University of Agricultural Sciences, Dharwad in India.

So such baffling conclusions through the views of several caused the *Bt* crops being banned or held upon with moratorium in many countries including India that imposed a considerable set back to the pace of biotechnology, especially genetic engineering technology. The fate of *Bt* crops still seems to be unfathomable but while the scientific debate to ascertain the *Bt* crops worthful or hazardous must continue, it should be looked after not the unscientific, unreal perceptions about the technology fasten the prudence of people.

20354

39. Gluten-Free Wheat: A New Aspiration for Cd Patients

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Wheat is the second most staple food in the world and a major source of carbohydrates. Gluten is a protein found in the endosperm of caryopsis of wheat, barley, and rye. It belongs to prolamins and glutenins class of proteins and forms 75-85% of the total protein content of wheat. Some individuals have a genetic disorder that they are not able to digest this particular protein. This state is called gluten intolerance which leads to a disease called coeliac disease (CD). There is an immune reaction to gluten due to which small intestine lining is damaged. Symptoms of this disease also include diarrhea, bloating, fatigue, anemia, and osteoporosis. Worldwide almost 1.4% of the population is suffering from CD and the only remedy for these patients is to follow a strict gluten-free diet lifelong.

A lot of Gluten-free products are available in the market but they are not as healthy as gluten-based equivalents because of the inclusion of

additives. In such a situation there is a huge demand for whole-grain wheat products lacking gluten but maintain baking quality as well as a safe and healthy option for CD patients. People who are suffering from CD and who are genetically susceptible to CD after prolonged gluten consumption can easily shift to CD-immunogenic wheat without compromising the quality of food. This calls for a gluten-free wheat breeding applying nutrigenomics. Nutrigenomics is a science that studies the relationship between human genome, nutrition, and health. Customizing a plant product according to patient's needs is a whole new approach of the modern era. The production of healthy and less CD-toxic wheat varieties is a very challenging task because many genes are involved in gluten metabolism which makes it a complex trait. A combination of several breeding techniques has to be applied; mutation breeding and genome editing are the most promising ones.

Mutation is a sudden heritable change that occurs in a population when exposed to any mutagen such as UV rays, gamma rays, X rays, etc. There is a probability to get a gluten-related gene modified but for such cases, a lot of population has to be screened; whereas as gene editing is making deliberate, specific, and precise changes in DNA by insertion, deletion, and replacement. Gene editing may up-regulate, down-regulate, or completely silence a specific gene. Many tools like CRISPR, TALENs, and ZFNs, etc are being exploited in the world of genome editing. CRISPR is a nucleotide sequence that guides an enzyme called Cas9 in recognizing and cleaving the site which is complementary to it. This cleavage leads to the inactivation of the gene because of no further transcription and translation. Jouanin *et al.* (2020) applied a locus-specific gene editing using CRISPR/Cas9 to gliadins. The offspring were found with silenced, deleted, and edited gliadins genes, hence reducing the exposure of patients to CD epitopes. RNA interference is another technique that can be utilized for gene editing. Complementary RNA sequence pair up with target mRNA and neutralizes it hence, translation is stopped and no protein product is formed. Barro *et al.* (2016) applied the RNAi technique for silencing the expression of different prolamin fractions. Six plasmid combinations provided a strong reduction in the gluten content as measured by anti-gliadin 33-mer monoclonal antibody (moAb) while maintaining total protein and starch contents.

One more approach which can be beneficial for achieving gluten-free wheat is through modification in the structure of concerned proteins by the formation of crosslinks using transglutaminase enzymes. Any peptidases can degrade gluten peptide chains into harmless fragments which reduces CD-immunoreactivity of that product. Scherf *et al.* (2018) extracted peptidases from various sources viz. germinating cereal grains, fungi, and lactic acid bacteria. The processed food products are reported to have significantly low gluten below the Codex (20mg/kg for gluten-free products). The aim is to develop whole grain wheat without gluten either it needs modifications at DNA level, transcriptome level, or metabolite level.

This article emphasizes the prospects of wheat breeding with low levels of gluten which are suitable for CD patient's consumption. The marketing of these modified products needs a proper legislative system for monitoring. This is to ensure that all safety requirements have been taken and raw materials containing gluten should be treated adequately to remove CD-active gluten fragments and they may be mixed with naturally gluten-free products to create an extended choice of high-quality gluten-free products. The ever increasing global demand for modified food may require the legislative issue to be addressed in the upcoming future by food processing industries and cereal breeding programs.

PLANT PATHOLOGY

20138

40. Bacteriocins

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Microbial population dynamics are primarily controlled by the products bacteria produce and excrete into their environment. This versatile and a dynamic suit of compounds order the defence mechanisms, rightly described as "a never-ending arms race" (Riley, 1998) against microbial

competitors and also as signalling compounds for plant colonization in a given soil. The excreted bacterial compounds were recognized now include a wide range of broad-spectrum non-ribosomally synthesized antibiotics, lytic enzymes (lysozymes), metabolic by-products such as organic acids, proteinaceous exotoxins, and chromosomally and/or ribosomally produced antimicrobial peptides, mentioned as bacteriocins that are of particular importance in bacterial defence.

It is supposed that the majority bacteria produce a minimum of one bacteriocin. Bacteriocins are extracellular substances produced by bacteria having distinctive morphological and biochemical characteristics, starting from a really low to high relative molecular mass complexes, wherein the activity is predominantly associated with a protein. They are mostly synthesized from plasmids, but many are of chromosomal origin as well and a resynthesized at various stages of bacterial growth and under various environmental conditions they affect the growth of related bacterial species. Bacteriocins are grouped into four distinct classes based on peptide characteristics such as post translational modifications, side chains, heat stability, N-terminal sequence homology, and molecular weight. Bacillus species were first reported to supply bacteriocins in 1976. The low-molecular-weight bacteriocins produced from the Gram-positive bacteria had reported the bactericidal activity, against certain other Gram-positive bacteria. Among the bacteriocins studied colicins of the family Enterobacteriaceae is well understood. Due to their commercial importance as natural preservatives, and as therapeutic agents against pathogenic bacteria, these antimicrobial peptides are a serious area of scientific research. Nisin, produced by *Lactococcus lactis*, is bacteriocin generally regarded as safe for human consumption (GRAS) but it has limatitation in usage, because of its ineffectiveness against Gram-negative bacteria which is necessitating for exploration of newer bacteriocins.

Classification of Bacteriocins

- Class I: the lantibiotics
- Class II: the small heat stable non lantibiotics
- Class III: large heat labile bacteriocins.
- Class IV: undefined mixture proteins, lipids and carbohydrates.

Characteristics of Bacteriocins

Bacteriocins should possess two qualities to become lethal *i.e. i*t should be cationic and highly hydrophobic. Most of the category I and II bacteriocins are cationic at pH 7.0. Their high isoelectric point allows them to interact at physiological pH values with the anionic surface of the bacterial membrane. This leads to insertion of the hydrophobic moiety into the bacterial membrane. This build up the trans membrane pore which cause gradient dissipation and cellular death. Heat-stability is one of the most important properties of bacteriocins. Possessing complex pattern of monosulfide and disulfide intramolecular bonds helps in stabilization of secondary structures generally by reducing the amount of possible unfolded structures (entropic effect). It was observed that most of the supernatants of bacteriocins producing strains are resistant to autoclaving conditions and heat treatment (100 and 121°C). However, some bacteriocins produced by Lactobacillus strains were inactivated by 10 to 15 min treatments of 60-100°C. Nisin produced by *Lactococcus lactis* strains, was discovered in 1928 and is most studied bacteriocins. It is made up of 34 amino acids and has 5 lanthionine bonds. It has antimicrobial activity, high solubility, and thermally stable at pH 2.0. It is inactivated at pH 7.0. Sensitivity of nisin to human digestive enzymes made it to choose as a product of choice as food preservative.

General Mode of Action

Bacteriocin act of target by forming membrane pores that disturb the energy potential of sensitive cells. Various bacteria produce different types of bacteriocins with different mode of actions. Mode of action of nisin is best studied. These bacteriocins associate electrostatically with phospholipids, which causes interaction of bacteriocins's hydrophobic residues with the cytoplasmic membrane of target cell. Electrostatic interaction is caused by Lysine (cationic amino acid). The interaction between the hydrophobic a part of nisin and membrane generates ionic channels. It is favoured by high transmembrane potentials, presence of anionic and absence of cationic lipids. It is hindered by divalent cations because they neutralize the negative charges of the phospholipids, reducing the fluidity of the membrane. Pores produced by nisin create passive efflux of K+ and Mg2+, amino acids, ATP and proton-motive-force dissipation and necrobiosis. Class I bacteriocins show a pronounced anti-listerial specificity thanks to the presence of sequence YGNGV in their N-terminal region. The current mechanism to elucidate mode of action includes electrostatic binding of antibiotic to the target membrane mediated by a putative membrane bound receptor molecule, although the need of this specific receptor is still controversial. The hypothetical receptor would be liable for the popularity of the YGNGV anti-listerial motif present in these peptides.

20228

41. Role of Calcium in Plant Growth and Development

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Calcium is an essential microelement with significant roles in plant growth and development. In plants, significant concentration of calcium is present (in milliMolars), but the requirement is in very less amount (in micromolars or µM). Generally, Calcium is not a limiting factor in open field area, but sometimes several calcium dependent defects are observed which include leaf necrosis, defects in root development, poor fruit storage, fruit cracking etc. Calcium (Ca^{2+}) is taken up by roots, with other nutrients from soil and delivered to various plant parts through xylem. The movement and accumulation of Ca^{2+} in plants is dependent on the cytoplasmic Ca^{2+}concentration in the cell, and the plants always strive to prevent toxicity of Ca^{2+}in cells. The cytoplasmic Ca^{2+}concentration is maintained by Ca^{2+}-ATPase and H^+/Ca^{2+}antiporters (White and Broadley, 2003). Calcium plays an important role in various plant functions, some of the important ones are discussed below:

- **Calcium and cell wall:** Ca^{2+} play an essential role for providing structural rigidity to cell wall. During cell wall synthesis, the acidic pectin residues are secreted in the form of methyl esters which get de-esterified with the help of enzyme pectin methylesterase. Later on, the liberated carboxyl group binds with calcium ions and provide rigidity to the cell wall. High calcification (calcium concentration in cell wall) inhibits shoot growth, whereas lesser amount of calcium deposition promotes cell and tissue elongation. Auxin shows antagonism with calcium because auxin promotes shoot growth while the high calcium cell wall inhibits shoot growth.
- **Calcium and membrane permeability:** Ca^{2+} ions play a crucial role in membrane structure and functioning. Ca^{2+}ions provide stability to phospholipid bilayer with the binding of ions with phospholipids. It also controls membrane permeability; lesser the concentration of calcium ions, more is the leakage of metabolites and ions. Pollen tube permeability is also dependent on the calcium ion concentration. Calcium ions are also involved in cytoplasmic streaming mediated by action potential of ion movements (Kudla *et al* 2010).
- **Stomatal opening and closing:** In some plants, Ca^{2+} ions stimulate stomatal closure by varying the Ca^{2+} concentration in cytoplasm. Ca^{2+}mediate two mechanisms for stomatal closure: short term Ca^{2+} reactive closure and long term Ca^{2+}programmed closure. In short term Ca^{2+}reactive closure, a rapid reaction of stomatal closure occurs with an instant elevation in cytoplasmic Ca^{2+} ion levels. Whereas, in long term Ca^{2+} ion programmed closure; the concentration of Ca^{2+} ions are under the range of specific amplitude, frequency and duration. Thylakoid membrane proteins contain calcium sensing receptors which may be involved in maintaining concentration of cell calcium and cytoplasmic mediated stomatal closure.
- **Pollen tube tip growth**: In pollen tube tips, high cytoplasmic calcium concentration is present at apex. It was suggested that cytoplasmic Ca^{2+}concentration oscillations play an important role in growth of pollen tube. Disruption of Ca^{2+}influx via various actions results in termination of pollen tube growth.
- **Abiotic and biotic stress response:** Elevation in heat and temperature results in the activation of calmodulin proteins; that get activated with binding of calcium ions to them. Other proteins like calcineurin B-like proteins (CBLs) and Ca^{2+}dependent protein kinases (CDPKs) are also involved to deliver the specific responses for various biotic and abiotic conditions (Kiegle *et al* 2000). Various other environmental factors like strong wind, touch etc. induce cytoplasmic Ca^{2+}concentrations and other distinct patterns.

Therefore, Ca^{2+}dependent factors such as specific cellular concentration and subcellular localization, Ca^{2+}binding affinity to various proteins, specific interactions and signals play an important role for proper growth and development of plants.

References

Kiegle, E., Moore, C.A., Haseloff, J., Tester, M.A. and Knight, M.R. (2000). Cell-type-specific calcium responses to drought, salt and cold in the Arabidopsis root. *Plant J.* **23:** 267–278.

Kudla, J., Btistic, O. and Hashimoto, K. (2010).

Calcium Signals: The Lead Currency of Plant Information Processing. *The Plant Cell.* **22:** 541–563.

White, P.J. and Broadley, M.R. (2003). Calcium in plants. *Annals of Botany*. **92:** 487-511.

20247

42. Importance of Phenolic Compounds and Disease Resistance in Crop Plants

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Phenolic acids are plant metabolites widely spread throughout the plant kingdom.

- Phenolic compounds are essential for the growth and reproduction of plants and are produced as a response for defending injured plants against pathogens.

Functions

- It shows antiauxin activities.
- Some are potent growth inhibitors.
- Gives disease resistance to plants.
- Also serve as protectants against insects

Biosynthesis of Phenolics Compounds

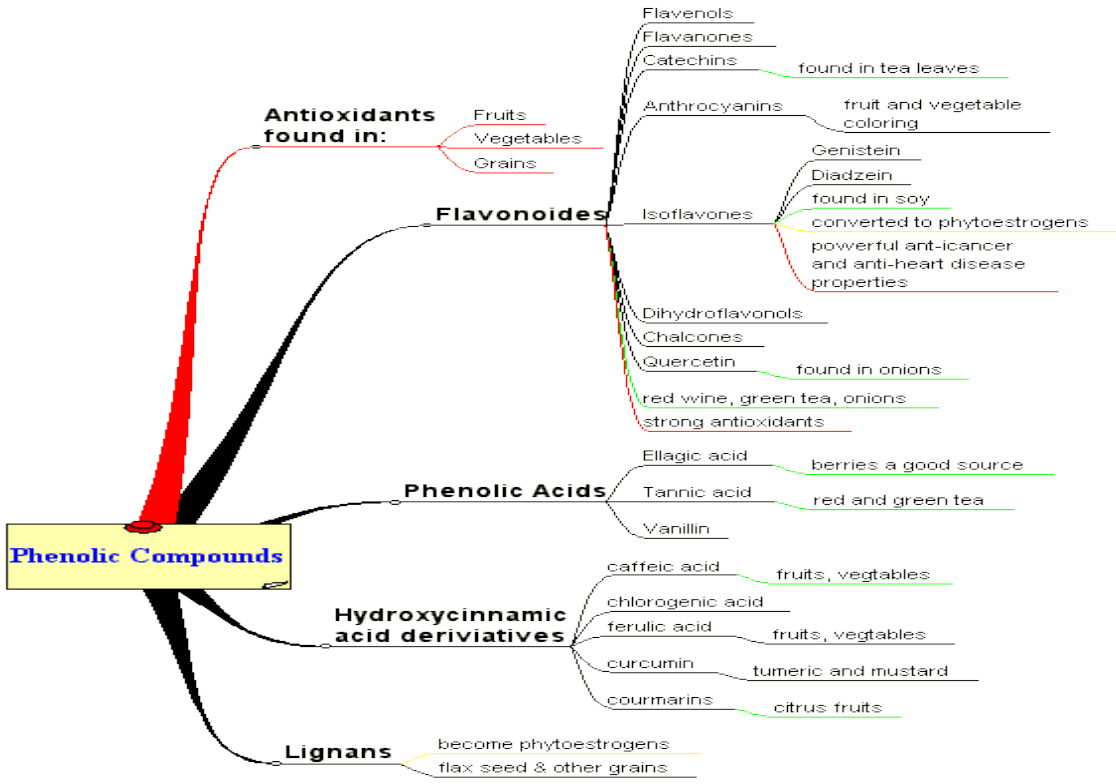
- Shikimic acid pathway
- Acetate malonate pathway
- Acetate – mevalonate pathway

Mode of Action

- The activity of Polyphenol oxidase (PPO) can oxidize phenolics to quinones, which may be more fungitoxic.
- The polyphenol produced by the pathogen may oxidize the host polyphenols to highly fungitoxic substances, which may prevent the further development of pathogen.
- Oxidized polyphenols inhibit the pectinolytic enzyme produced by various fungi and give resistance to diseases.
- Esterification of phenols to cell wall materials is a common expression of resistance.
- The inactivation of extracellular microbial enzymes by Phenols and Quinones present in plant act as defence mechanism.
- Aromatic substances such as poly phenols, flavanoids, anthocyanins, aromatic amino acids and coumaric derivatives are accumulate in and around infected tissue.
- The tissues adjacent to wounds, they exert fungi static effect.
- Oxidized phenols and oxidized phenolic glucosides are more effective due to ß-glucosidases, polyphenol oxidases & peroxidases.
- Phloretin gives resistance to scab of apple (*V. inequalis*).
- Arbutin gives resistance to pea shoot to *Erwinia amylovora*.

Response to Phenolic Compounds

- Formation of lignin
- Accumulation of cell-wall appositions such as papillae
- Early accumulation of phenols in host cell wall.
- In resistant Barley plants, the mycelia of *Erysiphe graminis* present in mesophyll cells, release phenolic substances.
- This accumulates around the haustoria and inhibits further development of the fungus.
- The phenols and their oxidation products showed the inhibitory activity on the pectolytic and cellulolytic enzymes of the pathogen *Cladosporium cucumerinum in* potato.
- **Polyphenols:** It enables resistance to *Venturia inequalis* and *V. pirina*.
- Flavones, Anthocyanine and simple phenolics such as protocatechuic acid and catechol in the bulbs of onion gives resistance to *Colletotrichum circinans.*
- **Cholorogenic acid** is responsible for the resistance of potato tubers to scab - *Streptomyces scabies.*
- This acid is present in the periderm of tubers of resistant variety
- Cholorogenic acid gives defence against the *Verticillium* wilt to potato.
- This acid is present in the root tips, sprout tips and the vascular system of resistant varieties.



20282

43. Bacterial Diseases of Banana: Current Status and Integrated Approaches for Sustainable Management

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Banana under the genus Musa of family Musaceae is one of the most important staple fruit crops in many tropical areas in terms of production and consumption (FAO, 2003). Among the several diseases of Banana, bacteria cause a significant impact on global banana production, and the diseases caused by them have not received much attention compared to other major threats such as fungal diseases. Symptoms caused by these bacteria in banana can be summarized as wilting, plant toppling, and rotting of the rhizome, pseudostem, and/or fruits. Wilting in plants is due to several factors such as plugging of the vessels due to extracellular polysaccharides, high bacterial cell densities, tyloses, and gums produced by plants (Denny, 2006). Hence much attention is required to study these potential disease-causing organisms and an integrated approach for sustainable management should be focused concerning future global food security.

Current status: Bacterial wilt in banana, although it is not as that severe as the fungal pathogens it has a potential role to damage the crop and increase the management cost practices worldwide. *Ralstonia solanacearum*, the causal agent of bacterial wilt, is currently found worldwide

between the Tropic of Cancer and Tropic of Capricorn. They have originated and evolved with changes in environment, host, soil etc. Moko disease caused by *R. solanacearum* is found to be a threatening disease in some countries of Latin America such a Brazil, Colombia, Mexico, Guyana and Caribbean. Bugtok disease and blood disease of banana, caused by the *Ralstonia* are more confined to Indonesian islands and the Philippines. Since 2001, Xanthomonas wilt has become the most important and widespread disease of *Musa* in East and Central Africa and spread worldwide. The other diseases causing pseudostem rot and rhizome rot is a serious disease in Colombia, Cuba, Guatemala, and Jamaica.

Bacterial diseases in bananas can be sorted out into three groups:

- **Ralstonia-associated diseases:** *Ralstonia solanacearum* strains affecting *Musa sp*. vary in their symptom expression which depends largely upon plants, cultural practices and mechanism of transmission by insects or by mechanical and soil transmission. The "SFR" (small, fluidal, round) and "A" (Amazon basin) strains are known to be transmitted by insect whereas the "B" (banana) strain is transmitted through root contact and mechanical transmission (Sequeira, 1998). Moko and Bugtok diseases differ with respect to strain and symptom expression. Moko causes yellowing and leaf wilting symptoms and is usually spread through mechanical transmission in medium- to large-scale Cavendish plantations, while Bugtok first shows fruit-rotting symptoms caused due to insect's vector inoculation through the male in balbisiana cultivars (Molina, 1999). Banana blood disease caused by *R. syzygii* subsp. *celebesensis* shows reddish discoloration of vascular tissue and reddish dry rot of the fruit pulp and is found to coexist with the Moko and Fusarium wilt diseases.
- **Xanthomonas associated wilt diseases**: Symptom expression of *Xanthomonas* wilt does not differ much from *R. solanacearum*. The incubation period for *Xanthomonas* wilt is about 3 weeks and those entering the plants through garden tool use, will first cause a systematic yellowing and wilting of the leaves. (Nakato *et al.*, 2014).
- **Erwinia-associated diseases:** Symptoms produced by bacterial head rot or tip-over disease (*Erwinia carotovora sp. carotovora* and *E. chrysanthemi*), bacterial rhizome and pseudostem wet rot (*Dickeya paradisiacal* formerly *E. chrysanthemi* pv. p*aradisiaca),* causes translucent spots on sheaths in different parts of the pseudostem or in the base of leaves which later become reddish-brown, and finally take a dark brown color and ultimately rotting and necrosis stops when it reaches the bunch stalk.
- Bacteria associated with banana soft rots such as D. *paradisiaca* (previously *E. chrysanthemi*), and *P. carotovorum* show rotting symptoms with poor sprout emergence, yellowing, wilting, and dwarfing.

Management Practices

The integration of cultural practices with sensitive and specific diagnostic tools, biological control methods, and conventional breeding may offer a more sustainable and environmentally friendly approach to control bacterial diseases. Disease management is followed by 6 principles which include: Avoidance, Exclusion, Eradication, Protection, Host resistance, and Therapy. The first critical step in plant disease management is diagnosis at proper and regular intervals, followed by disease indexing.

Disease Management Practices for a Sustainable Approach

Regulatory method: The first step in disease management is to prevent the movement of pathogenic bacteria from infested to non-infested areas by imposing quarantine regulations on vegetative propagules, suckers, soil, or packing material.

Cultural method: Where a disease is already endemic cultural management should be systematic such as minimizing contact with animals/laborers as much as possible, others include sanitation, practices, roguing, crop rotation with non-host crop, management of irrigation, management of host nutrition, management of soil acidity and alkalinity, organic amendments of soil, elimination of secondary host plants, removal of male flowers (de-budding) and early bagging of fruit clusters to reduce insect vectors (Soguilon *et al.*, 1995).

Physical method: Most plant pathogenic bacteria are usually killed at temperatures between 60°C and 70°C. *Ralstonia solanacearum* population can be reduced if soil solarisation is done.

Biological method: Although biological control agents have shown to protect crop plants from diseases under experimental conditions, inconsistent difference has been seen in the field conditions. Microbes like *Bacillus*, *Pseudomonas*, *Azotobacter*, *Streptomyces*, etc. have been found suitable in suppressing bacterial wilt diseases. Biological control agents can be used where chemical pesticides are banned (organ chlorines; methyl bromide) or where pests or pathogens have developed resistance to conventional pesticides

(Butt *et al*, 2001).

Host Resistance: Evaluation of clones for disease resistance is one of the best effective ways for implementation of integrated disease management programs in a sustained manner. Previously many researches have been conducted through traditional breeding to develop tolerance in potato, tomato, brinjal, tobacco, *etc.* Very little effort has been made to develop disease resistance in *Musa* hybrids and very few cultivars or wild varieties have been found showing true resistance or tolerance (Soguilon *et al.,* 1995), None of the commercial *Musa* cultivars *i.e.* AAA cultivars (*e.g.*, 'Grande Naine,' 'Petit Naine,' 'Gros Michel,' 'Valery,' etc), plantains (AAB) and wild *Musa* (comprising *M. balbisana, M. salaccensis M. ornata, M. acuminata,*) appeared to be resistant to the banana bacterial diseases.

Farmers Field Schools (FFS): It is a traditional education-oriented approach where farmers are assisted informally to remain aware and gain knowledge within their own environment. The FFS is a community-based approach that helps farmers to make correct crop management decisions economically, exposes farmers to new ideas and solutions. (Nankinga & Okasaai, 2006).

Conclusion

Banana (Musa sp.) which is one of the most important edible global food crop plants is continuously facing major threats in terms of pathogen attack. Though the bacterial wilt of banana is serious in certain countries, it has immense potential to create havoc worldwide. Following a coordinated, systematic, and integrated approach for disease management and creating awareness among the farmers community should be the best option to keep the disease under control.

References

Arias, P. (2003). *The World Banana Economy. 1985-2002* (No. 1). Food & Agriculture Org.

Butt, T. M., and Copping, L. G. (2000). Fungal biological control agents. *Pesticide Outlook. 11*(5):186-191.

Denny, T. P. (2006). "Plant pathogenic ralstonia species," in *Plant-Associated Bacteria*, ed. S. S. Gnanamanickam (Dordrecht: Springer). 573–644.

Molina, A. B. (1999). Fruit rot diseases of cooking banana in Southeast Asia. *Infomusa* 8: 29–30.

Nakato, G. V., Ocimati, W., Blomme, G., Fiaboe, K. K. M., and Beed, F. (2014). Comparative importance of infection routes for banana *Xanthomonas wilt* and implications on disease epidemiology and management. *Can. J. Plant Pathol.* 36:418–427.

Nankinga, C., & Okasaai, O. (2006). Community approaches used in managing BXW in Uganda. In E. B. Karamura, M. Osiru, G. Blomme, C. Lusty, & C. Picq (Eds.), *Developing a regional strategy to address the outbreak of banana Xanthomonas Wilt in East and Central Africa: Proceedings of the banana Xanthomonas wilt regional preparedness and strategy development workshop held in Kampala, Uganda, 14–18 February 2005*. 56–60

Sequeira, L. (1998). "Bacterial wilt: the missing element in international banana improvement programs," in *Bacterial Wilt Disease: Molecular and Ecological Aspects*, eds P. Prior, C. Allen, and J. Elphinstone (Berlin: Springer-Verlag). 6–14.

Soguilon, C. E., Magnaye, L. V., and Natural, M. P. (1995). Bugtok disease of banana. *Musa Disease Fact Sheet* 6, INIBAP, Montpellier, France.

20285

44. Plant-Pathogen Interaction and Defense Mechanisms in Plants

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Introduction

The population growth and sustainable development are the major concern of twenty first century. The world population is expected to reach about 10 billion by 2050. It is really challenging to feed more mouths of burgeoning population with the limited resources. Though there was a marked jump in the food production during 1960s due to green revolution but increasing population in increasing rate made this effect in jeopardy. Beside this, shrinkage of agricultural land, depletion of ground water, increased frequency of drought and

flood as a consequence of climate change, achieving yield plateau of most of the mega crop varieties are making more pressure on global food production system. Attaining the goal of zero hunger relies on both quantity and quality of food production. The quantity and quality of food grain is badly affected by several biotic and abiotic factors. Infestation of disease and pest is one of the major factors rendering reduced availability of food, thus posing major threat to food security. At a global level, plant diseases and pests are responsible for 20-40% losses of food production every year. With the changing climate scenario, some minor pests or diseases are also emerging out as a major one getting favourable environment for growth. Due to emerging new pathogens or re-emerging new virulent strains of major plant pathogens, controlling plant diseases always remained as an uphill task.

Plant-Pathogen Interactions and Mechanisms

Plant pathogens are a group of microbes consisting of virus, bacteria and fungus mainly. Plant pathogens are not a new entity. Plants and microbes co-evolved during the process of evolution. Since then interactions between them is present just like the web of interactions present among the components of an ecosystem with each other. Pathogens mainly interact with host plants for the sake of either nutrition or completion of nutrition. Some pathogens get nourished from the food materials produced by the plants and some need a host to complete their life cycle. Based on their modes of interactions, they are categorized as necrotroph, biotroph or hemi-biotroph. Successful development of disease depends on the following factors- host plant must be susceptible; pathogen will be virulent and environment is favourable for pathogen. Plant system is exposed to millions of microbes. But they all do not cause disease.

Compatible and Incompatible Reactions

Compatible reaction between host and pathogen determine the development of disease susceptibility or resistant reaction. Microbes when become associate with host surface produce some molecules, called Pathogen Associated Molecular Pattern (PAMP). These are conserved molecular motif related to specific strain of pathogen. Similarly, compatible are having pattern recognition receptors (PRR). PAMPs may be different kinds of glycoconjugates, lipopolysaccharides, endotoxins, bacterial flagellin etc.

On the other way similarly according to gene for gene concept, pathogens having *avr* (avirulence) gene directs to produce elicitor molecule and host having *R* (resistance) gene produce specific receptor in cell membrane. The elicitor binds to specific receptor. This binding initiates a cascade of biochemical reactions chain mediated by kinase enzyme. This reaction induces hypersensitive response (HR) which localize the pathogen in infected cell and kill it by restricting its spread. Another result from this reaction cascade may develop systemic acquired resistance (SAR) in which the signal for resistance reaction is transmitted throughout the plant system.

Plant Defense Mechanism against Pathogen

Constitutive Defense Mechanisms: These are the first line defense mechanisms. It includes pre-formed, pre-existing, passive physical or chemical defense systems that are already present in plants even before infection by pathogens.

- **Waxy layer** above plant leaf and stem are composed of aliphatic compounds which repel water on plant surface that is essential for germination of pathogenic spore.
- Cutinized **Cutin** layer also prevent pathogen to come in direct contact of epidermal layer.
- Polymerization of cellulose, hemicellulose, lignin, organic compounds or accumulation of silicon in **Epidermal Layer** impart resistance against pathogen like *Xanthomonas*, *Pythium* etc.
- **Lignified Cell Wall** is impermeable to several pathogens.
- **Guard cells** help to close stomata sensing the presence of PAMPs.
- **Trichomes** and **Thorns** also provide physical and chemical barriers to several pathogens like *Cercospora* and insect pest caterpillar to reach to the epidermal layer.
- **Ideoblasts** are modified cells containing toxin or crystalline substances that repel several pests.
- Plants liberate some chemical compound also. Some of them are toxic, some are having antimicrobial properties through which they repel pests. Most of these chemical compounds are secondary metabolite in nature. Terpenoids (in Basil, Mint, Black pepper, rosemary and bay leaf), diterpenoids (gossypol in cotton), triterpenoids (saponin), alkaloids (Caffeine, morphine, nicotine, cocaine), cyanogenic glycosides etc. are some antimicrobial compounds. **Phytoanticipins** are a group of low molecular weight chemicals that are stored in plants in inactive form but act as toxic against pathogen.

Induced Defense Mechanisms: Such type of mechanisms is developed in response of host-pathogen interaction. So these are post-formed or induced.

- Development of **cork layer** provide protection against scab of potato.

- Plants can remove its infected part along with pathogens by developing **abscission layer**.
- **Tyloses** are protrusion of parenchymatous cells of xylem vessels. It prevents the movement of pathogens through xylem vessels.
- The **Gummy Substances** produced by plants (mainly in stone fruits) inhibits the progression of pathogens.
- **Papillae** are callose deposition on the inner layers of cell wall in response of fungal pathogen attack.
- **Necrosis** of tissue surrounding the infected cells.
- Production of **Phytoalexins**, lipophilic compounds in response to pathogen attack, stress or other physiological stimulation hinder the growth of pathogens by altering the cell membrane and inhibiting oxidative phosphorylation. Example of phytoalexins are- medicarpin (alfalfa), rishitin (potato), pisatin (pea), cicerin (chick pea).
- The resistant varieties of some crops have the capability to produce **detoxifying enzyme** which can inactivate some enzyme related to pathogenesis.
- The rapid production and accumulation of reactive oxygen species (ROS) like- superoxide radical, hydrogen peroxide is called **oxidative burst**. Oxidative burst in plant cell promotes crosslinking of cell wall proteins, phytoalexin biosynthesis, defense related gene activation, induction of hypersensitive response.

Now a day's pathogens are coming out with more virulent strains that are very challenging to control. Sustainable approach of crop production alongwith integrated pest management can resist production of superbugs.

20301

45. Black Banded Disease: An Emerging Threat to Mango Cultivation

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Mango (*Mangifera indica* L.) belongs to the family Anacardiaceae, is one of the world's most important and esteemed fruits. By the virtue of its wide range of adaptability, delicious taste, superb flavour, very high nutritive and medicinal value as well as great religio-historical significance, it is rightly titled as "King of the fruits".

India enjoys the status of largest cultivator and producer of mango in the world which contributes about 50 per cent of total production of the world. There are several strengths in Indian mango cultivation such as traditional knowledge, biodiversity, research and development, domestic uses and demand. Threats to mango cultivation emanates from climate change, low level mechanization and emphasis on new products developments, incidences of diseases and insect-pest attack.

Diseases are one of the major constraints in the profitable mango production as they inflict heavy losses every year. Fungi cause the largest number of diseases while bacteria, algae, angiospermic parasites, gases and nutritional imbalances are the causal agents of many other maladies. They attack almost every part of trunk, branch, twig, leaf, petiole, flower and fruit (Mukherjee and Litz, 2009). Black banded disease is also one among the many fungal diseases of mango, earlier it was considered as disease of minor importance, but in recent years it is spreading widely and coming up as a serious malady in some parts of the country including Karnataka. The disease was first time recorded by Massee (1901) from Poona, India. He described *Rhinocladium corticolum* Massee as a causal agent of black banded disease of mango (Saccardo, 1906). Later Subramanian (1956) renamed the pathogen as *Peziotrichum corticolum* (Massee) Subram. Presently both names are used as synonyms, but now a days *Peziotrichum corticolum* is most commonly used as causal organism of black banded disease of mango.

The disease was characterised by the presence of irregular, raised, black, velvety patches or bands of fungal growth. The young mycelium near the periphery of the infection band was white or hyaline. Fungal growth was found to be covering the major part on bark of the lateral branches and twigs. The incidence of this disease on the main branches and trunk was relatively low. The fungal growth was also found covering petioles, midribs and veins of the leaves on both the surfaces however, the growth was only superficial. When

the fungal cover was gently removed no difference in colour was observed between the infected and healthy portions of the leaf. Leaf axils and crotches were found to be congenial for initiation of infection.

The patches on branches continued to grow and cover the cut surfaces of branches when the bark of the branch was chopped off along with a portion of black band on it. This showed that the fungus is capable of growing not only on the bark but also on the combined portion of the stem. During the rainy season, the infected portions of the bark were usually studded with plenty of mycelial growth, thereby presenting a velvety appearance. However, drop off in summer months, leaving only faint black bands in the affected areas. Dropping of mycelial growth began in the centre of the patch and extended towards the periphery as the summer progressed. With the onset of rains generally during July to August fresh velvety growth of mycelium was observed on the existing patches or bands of the previous year. Thus, the length of same black band goes on increasing year after year besides initiation and growth of new bands.

This disease was observed to be present either in mild to severe problem in many orchards, incidence and severity of this disease is increasing from last few years, warranting management practices.

A) On Twig B) On Branch and Hyaline Growth on Periphery C) On Leaf

Fig. 1. Symptoms of Black Banded Disease on Different Parts of Mango

References

Mukherjee, S. K. and Litz, R. E., (2009). Foliar, Floral and Soil borne Diseases. In: The Mango Botany, Production and Uses. Ed. Litz, R. E., p. 246.

Massee, G. E., (1901). Fungi Exotici, III. *Bull. Misc. Inform*., Royal Botanical Gardens, Kew, England, pp. 150-169.

Saccardo, P. A., (1906). Sylloge Fungorum. Patavii sumptibus auctoris pubisher, Italy, p. 572.

Subramanian, C. V., (1956). Hyphomycetes - II. *J. Ind. Bot. Soc.*, **35 (4)**: 446-494.

20349

46. Endophytes: Concepts and Applications in Agriculture

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Introduction

Endophytes are the microorganisms living inside the plants without any apparent disease symptoms. Hardoim *et al*., (2015) defines endophytes as "Microorganisms that spend at least parts of their life cycle inside plants". History indicates huge potential of these endophytic microbes in production of novel secondary metabolites, especially in life saving drug discovery. Endophytes have beneficial role in plant growth too. They help in several plant processes like nutrient uptake, growth promotion, biotic and abiotic stress tolerance, etc. Endophytes are emerging as potential tool to support sustainable crop production and protection. It has proven impacts on plant growth promotion, biological control and alleviation of abiotic stresses. Exploring over the huge diversity of endophytes can bring potential strains which add to the valuable genetic stock biological agent for sustainable agriculture.

Ecology of endophytes: The acquisition of endophytes depends on several physio-chemical and biological factors. Geographical and seasonal factors affect the assemblages of endophytic fungi as they are subjected to different selection pressure at each ecological niche (Petrini, 1991). Saxena *et al.,* 2019 critically noticed that plants growing in greater biodiversity and special habitats like deteoriated ecological environment conditions, (*Piriformospora indica*) isolated from cactus in deteriorated environment, plants surrounded by pathogen infected plants showing no symptoms, plants that have been exploited for human use as a traditional medicines in some places should be considered and plants occupied under certain ancient landmass were also likely to lodge good endophytes

Mode of entry: Endophyte gets the benefit of the niche close to host which bypasses the complex competition for food and space with other microbes as it happens in rhizosphere. Research has been conducted to confer mode of entry of endophyte to the plants. Apart from seed transmitted endophytes which are already present in plants, root is the major source of entry. However, there are other possible sites like in fruits endophytes can enter through flowers, natural openings of leaves (stomata or lenticels).

Biotic stress alleviation: It is not evident that all endophytes are involved in protection against pathogens, but reports indicates strongly that the endophytes are having huge potential to be used as excellent biocontrol agents as they endorse disease tolerance against wide array of plant pathogens. Induced systemic resistance (ISR), production of antifungal compounds-surfectin, fungicin, proteases, chotinases, siderophore production, competition for nutrients, volatile organic compounds, etc. are few of the major mechanisms of pathogen suppression by endophytes

Abiotic stress alleviation: Plants to have its internal capability to withstand certain amount of salt stress. Some of the beneficial microbes also enhance the plant tolerance to such stresses by multiple times. Mayak *et al.,* (2004) has reported use of plant growth promoting bacteria for salinity alleviation, by studying ACC-deaminase producing *Achromobcter piechaudii* strain enhanced growth and production of tomato seedlings up to an extent of 172mM concentration of sodium chloride. Palaniyandi *et al.,* (2014) have studied salinity stress –alleviating activity of streptomyces strain PGPA39 was evaluated using "Micro Tom" tomato plants with 180 mmol 1-1 Nacl stress under gnotobiotic condition

Conclusion: Endophytes have great promise to become successful inoculants for agriculture production by having novel secondary metabolites and bioactive compounds. Endophytes confers a large array of advantages to its host plant like dinitrogen fixation, phosphorus solubilization, IAA production, cytokinin production, vitamins production, ACC deaminase, osmotic balance etc. which signifies its sustainability to be used as inoculants in agriculture.

References

Hardoim, P.R., Van Overbeek, L.S., Berg, G., Pirttilä, A.M., Compant, S., Campisano, A., Döring, M. and Sessitsch, A. (2015). The hidden world within plants: ecological and evolutionary considerations for defining functioning of microbial endophytes. Microbiology and Molecular biology. Reviews. **79**(3):293-320.

Palaniyandi, S.A., Damodharan, K., Yang, S.H. and Suh, J.W., 2014. *Streptomyces sp*. strain PGPA39 alleviates salt stress and promotes growth of 'Micro Tom'tomato plants. Journal of applied microbiology, **117(3):** 766-773.

Petrini, O., 1991. Fungal endophyte of three leaves. In: Andrews, J. and Hirano, S. S. (eds.), Microbial ecology of leaves. Spring-Verlag, New York, pp. 179-197

Saxena, A. K., Sahu, P.K., Singh Udai B., Chakdar, H., Bagul, S.Y., 2019. Bacterial endophytes in agriculture: concepts to application-A Training Manual. Published by Director, ICAR-National Bureau of Agriculturally Important Microorganisms, Kushmaur, Maunath Bhanjan, Uttar Pradesh (India), 1-123.

20379

47. Life cycle of *Phytophthora*

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Taxonomic Position of Pythium

Domain:	Eukarya	Kingdom:	Chromista
		Phylum:	Oomycota
		Class:	Oomycetes

Order:	Peronosporales
Family:	Peronosporaceae
Genus:	Phytophthora
Species:	infestans

Symptoms

- The destructive disease known as great IRISH FAMINE was due to *Phytophthora* (plant destroyer).
- Water soaked, light brown lesion develops on the leaf, later enhances also coalesces covering the entire leaf, petiole and stem.
- Fungal growth seen in the affected area as rotted and white, purple black lesions are also seen.

Perpetuation

- Primary infection is through infected tubers and (oospores) infected soil.
- Secondary infection through sporangia carried by wind or irrigation water.

Life cycle

Asexual reproduction

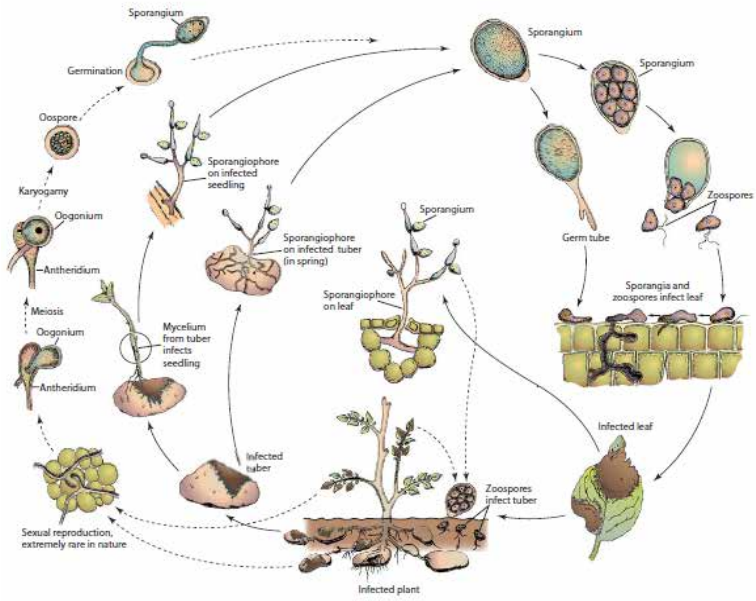
Sporangia are means of asexual reproduction Hyphae are inter and intracellular profusely branched, coenocytic long curled finger like haustoria into the leaf cells. The sporangiophores are with characteristic swellings of node and are of indeterminate growth. They emerge out of the host singly or clusters through stomata or by directly piercing the epidermal cell wall bearing thin walled, hyaline to light yellow, spherical to oval, multinucleate lemon shaped papillate sporangia at the nodes. The sporangia bear a basal plug.

Whenever sporangia come in contact of host it germinated. Temperature less than 15°C favours zoospore production which may uninucleate, biflagellate (whiplash and tinsel), kidney shaped. Whereas temperature more than 20°C favours germ tube development. After the zoospores come to rest they encyst and each germinate by a germ tube which produces an appressorium,

Sexual reproduction

Sexual reproduction takes place by the mode of antheridia and oogonia of opposite mating types (heterothallic fungus). Protoplast of the oogonium is differentiated into an outer multinucleate periplasm surrounding a central uninucleate ooplasm. The central nucleus divide into two. One of the nuclei disappears and the other as (egg) oosphere nucleus. The oogonia penetrate and grow through the antheridium and form a globose structure above the antheridium,

This type of antheridium is known as amphigynous antheridium. Both the oogonia, and antheridia are multinucleate in the beginning but as they mature only a single nucleus is left that probably undergo meiosis before fertilization. Migration of the single antheridial nucleus occurs through the oogonial wall by a fertilization tube and fusion takes place. The fertilized egg secretes a heavy wall around itself and became an oospore (resting spore). After a rest period of several weeks the oospore germinates by means of germ tube which terminates in to a germ sporangium. It produces the zoospores and the zoospores germinate to produce new thalli.



Life cycle of *Phytophthora*.

PLANT PROTECTION

20243

48. Major Insect Pests of Citrus and their Management in Mizoram

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There are a large number of insect pests of citrus which are widely distributed. Their attack and that of nematodes are some of the factors contributing to the problem of citrus decline observed in various parts of South Asia as well as North Eastern State of India including Mizoram. By controlling this pest, the citrus decline can be arrested to a considerable extent, at least in those places where pests are a serious problem.

Citrus Psylla: *Diaphorina citri* (Psyllidae: Homoptera)

Damage: Both nymphs & adults suck the plant sap bu nymphs are more destructive. The insets also inject certain toxins along with the saliva while feeding: as a result, the adjacent branches that are not actually attacked also dry away. Besides the bug also secretes honey dews resulting in superficial black coating of the plant surfaces. The pests also act as a vector of citrus greening bacterium.

Management

1. Conservation and augmentation of natural enemies such as *Coccinella septempunctata*, *C. rapanda*, *Menochilus sexmaculatus*, *Brumus sutaralis*, *Chrysopa* spp. and syrphid flies. *Tetrastichus radiates* and *T. phyllocnistoids* are nymphal parasitoids.
2. Before opening of flowers or spring flush, spray Dimethoate (0.03%).
3. If necessary, spray should be repeated after the fruit set.
4. During August-September, the spray should be given to cover the second flush of growth.

Citrus Whitefly: *Dialurodes citri* (Aleyrodidae: Hemiptera)

Damage: The pest causes damage in larval and adult stages. It sucks the cell –sap from leaves which curl over and fall off. The honey dew excreted by the nymphs is a very good medium for the growth of sooty mould, which interferes with photosynthesis. Thus, the trees infested with this pest deteriorate further.

Management

1. For effective management of flies, close planting, water logging or any other stress condition should be avoided.
2. *Encarsia laborensis* parasitized nymphs of white flies. *Brumus suturalis*, *Chrysopa* sp., *Scymnus* sp. And *Lasius* sp. Are the predators of eggs and nymphs.
3. Spraying with Malathion, Acetamiprid @ 0.5%, Dimethoate (0.03%) during April- May and again during Sept – Oct.

Citrus Mealy Bug: *Pseudococcus* Filamentosus Cockerell (Hemiptera: Pseudo- Coccidae)

Damage: The insects feed on cell – sap and the plants become pale, wilted and the affected parts eventually die. The insects also excrete honey dew on which a black mould grow, which interferes photosynthesis. Black ants are attracted to the honey dew and they become a nuisance. In severe cases of infestation, the citrus flower do not set fruit.

Management

1. Orchard sanitation is important, weed act as additional hosts and these must be removed.
2. The ant colonies should be destroyed by ploughing the soil around trees and by application of Quinalphos or Chlorpyriphos @ 2ml/litre of water.
3. The coccinelid beetle, *Cryptolaemus montrouzieri* should be released @ 10 beetles per plant to control mealy bugs.
4. The chemical control should be same as in case of Psylla.

Citrus Caterpillar / Lemon Butterfly: *Papilio demoleus Linnaeus* (Lepidoptera: Papilionidae)

Damage: The young caterpillars feed on tender leaves and grown up caterpillars are voracious feeders. Foliar damage by caterpillars is observed to synchronize with the fresh growth of plants. It is a major pest for young plants.

Management

1. Hand picking of various stages of the caterpillars and killing by dropping in kerosinized water especially in nurseries and the new orchards help to suppress the population of the pest.
2. Spraying of Quinalphos (0.05%) or Cypermethrin (0.01%)
3. Spraying of neem seed kernel extract (NSKE) (5%) gives high mortality of caterpillars.

Citrus Leaf Miner: *Phyllocnistis citrella* (Gracillaridae: Lepidoptera)

Damage: The caterpillar mines only tender leaves, old leaves are avoided. They feed on epidermis making zig zag galleries, characteristic of minor damage. Infested leaves turn pale, curl and get dried. The infestation is also suspected of aiding infection bacteria which cause citrus canker. Sometimes larvae also mine epidermis of tender shoots.

Management

1. Spray of 2% neem extract has been found quite effective and safe.
2. Spraying of Imidaclorprid @ 2 ml/litre or Traizaphos @ 3ml/litre of water or Cypermethrin 0.01%
3. Abacmectin plus petroleum spray oil @ 1.5g (a.i) + 50 ml/100 litres of water is effective.
4. Infected leaves should be collected and burnt. On grown up plants, no control measures are necessary as the plant can recovered the injury.

Citrus Trunk Borer: *Anoplophora versteegi* (Lamiidae: Coleoptera)

Damage: Adult females deposit the eggs singly after making a slit on the bark and insert the egg. Prefer to lay eggs within one-meter height from the ground level. The grubs after hatching feed beneath the bark for few days and tunnel deep in the sapwood in later stage. Appearance of resinous exudation is a common symptom in the early stage of infestation. Sawdust like powders are seen expel from the entry holes as well from the exit holes in the later stage of infestation. Adults are seen feeding on leaves from April – July. Large exit holes are prepared during November – January.

Management

1. Collection and destruction of adult during April to July, by shaking the trees to dislodge the adults feeding on leaves and twigs.
2. Smearing of trunk upto 1m height with a mixture of Lambda cyhalothrin + Lime + water (1: 10: 100).
3. Foliar application of Profenophos (2 ml/litre) or neem formulation (4ml/litre of water) 3 times during April – July.
4. Encouragement for existence of predatory ants like *Oecophylla smaragdina*, *Camponatus compressus*, *Tetraponera rufonigra*, *Pheidole* sp., *Monomorium floricola.*

NEMATOLOGY

20252

49. Entomopathogenic Nematodes for the Management of Plant Parasitic Nematodes

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The biodiversity on soil fauna is an important key to determine the ecosystem functions. Chemical management of insect pests often disturbs the population and densities of target, non-target organisms and also indirectly influences the associated soil food web, thereby the diversity and species richness of the native communities was affected and found to be reduced. Nematodes are wide spread soil fauna which plays an important role in regularizing the primary production, predation, decomposing the organic matter and recycling the nutrients by interacting with ecosystem either directly as plant herbivores or indirectly by consuming the soil microflora and fauna. Entomopathogenic nematodes are gaining importance world-wide as an important tool of biological control because of its wide host range and high efficacy. More importantly it does not harm mammalian and found to be safe. Recently, with the available mass production techniques are more economic which has increased the utilization of the nematode as major biological agent.

Entomopathogenic Nematodes

Entomopathogenic nematodes belonging to the genera *Steinernema* and *Heterorhabditis*

(Nematoda: Steinernematidae and Heterorhabditidae) are insect parasitic nematodes. The third stage juveniles are infective but non feeding enters into the haemocoel through natural openings of host insects and releases its symbiotic bacteria *viz*., *Xenorhabdus* spp. (Steinernematidae), and *Photorhabdus* spp. (Heterorhabditidae). These nematodes and its respective bacteria releases toxins which causes septicaemia in insects and kills them within 48h after infection and completed two to three generations within the same hosts. When the host cadaver is consumed fully, they produce the third infective juveniles and leaves the cadaver in soil for searching new host and continue the cycle. In addition to insect it also reduces the population, diversity and development of the plant parasitic nematode groups in the soil.

Mechanisms of Suppression

The suppression of plant parasitic nematodes by entomopathogenic nematodes various mechanisms are explained by researches. Crowding is a type of exclusion where the EPNs gather near the root zone of the plant which eliminates the plant parasitic nematodes near the plant root zone. By applying enormous dose of EPNs in soil, their population gets build up and behave like antagonistic organisms and suppresses the population of plant parasitic nematodes in the soil. Allelochemicals like ammonium and indole produced by entomopathogenic nematodes and/ or their symbiotic bacteria (*Xenorhabdus* spp. and *Photorhabdus* spp.) inhibit egg hatching and repel or intoxicate plant parasitic nematodes.

Movement of Entomopathogenic Nematodes towards the Plant Root Zone

Carbon dioxide is eliminated by all living organisms in the earth and hence the nematodes uses CO_2 as important cue more definitely as long-distance cue for the identification of their hosts. Volatiles secreted by plants roots or induced plant volatiles attracts both plant parasitic and entomopathogenic nematodes. In some plant's attractants are released either by the plants or induced by pest damage. For example, in citrus variety, Swingle when damaged by *Diaprepus abbreviates*, a root weevil, the plant root produces C_{12} terpenes, Pregeijerene and its breakdown product, Geijerene which attracts both the EPN (*Steinernema diaprepesi*) and plant parasitic nematode (*Tylenchulus semipenetrans).*

Antagonists Development

The entomopathogenic nematodes accumulated near the plant root zone which develops as a general antagonist against plant parasitic nematodes and reduces its population indirectly. To characterize the soul communities, a molecular method called probing was done using the samples of nematode DNA collected from a citrus orchard. The samples consist of Acrobeloides group nematodes, other EPNs like *S. diaprepesi, H. indica and Heterorhabditis zealandica*) and also complex of nematophagous fungi comprising *Catenaria* sp. and *Monachrosporium gephyropagum*. These entomopathogenic nematodes are natural enemies of EPNs and showed positive correlation. The development of general antagonists can be explained by using Linford hypothesis which claims that the decomposition of organic matter (insect cadavers) greatly increases the population of bactivorous nematodes and the respective natural enemies.

Allelochemicals

The multiple allelochemicals secreted by the insect cadavers, different life stages of nematodes present in the insect cadavers and their symbiotic bacteria together regulate the population of the plant parasitic nematodes. EPN infected cadavers generally releases ammonia which is toxic to many biological systems. Secondary metabolite *viz*., – 3,5 – dihydroxy dihydroxy-4- isopropulstilbene secreated by the infected cadavers find to inhibit the egg hatching in *Meloidogyne incognita*. Nematodes like *Xenorhabdus* and *Photorhabdus* synthesis some agents with nematicidal and antimicrobial property, which helps the deceased insects for the development of entomopathogenic nematodes. Antimicrobial agents present in the EPN are non-protein indoles, xenorhabdins, xenocoumacins, stilbene derivatives, enzymes like proteinaceous, chitinases and bacteriocins.

Induced Systemic Resistance

In a recent finding the application of EPN to rhizosphere induces systemic response in plant system. To study the effects of EPNs, *Steinernema carpocapsae* and its respective symbiotic bacterium, *Xenorhabdus nematophila* was introduced in to the potting medium to determine the activity of pyrogallol peroxidase (P-peroxidase), guaiacol peroxidase (G-peroxidase) and catalase of *Hosta sp*. and *Arabidopsis thaliana* leaves as part of induced systemic resistance study. The results were found to be positive showing increase in all the three enzymes which plays a major role in induced systemic resistance. The increased level of enzymes may be due to the over expression of PR-1 gene level.

Perspective

Number of works had been carried out in laboratory and green house conditions, with special reference to root knot nematode. The research shows that when *S. riobravis* and *S. feltiae* applied at the rate of 25 IJs/cm^2 before

or after and *H. bacteriophora* applied before *M. incognita* infestation. *M. incognita* penetration and egg production on tomatoes was suppressed by the entomopathogenic nematodes. The high application rates of *S. asiaticum*, *S. glaseri*, *H. indica* and *H. bacteriophora* applied 24 hours before *M. incognita* infestation reduced *M. incognita* egg production. The low rate of *S. asiaticum*, *S. glasri*, *H. indica* and *H. bacteriophora* were not as effective as high application rates which suppressed *M. incognita* egg production on tomatoes.

20348

50. Factors affecting Nematode Survival in Formulations

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Introduction

A plethora of nematode species in more than 30 families are associated with insects and other invertebrates. The major focus of research and development has been on nematode species in 7 families, Mermithidae, Tetra-donematidae, Allantonematidae, Phaenopsitylenchidae, Sphaerulariidae, Steinernematidae, and Heterorhabditidae, because of their potential as biological control agents of insects. The entomopathogenic activity of steinernematid and heterohabditid species has been documented against a broad range of insect pests in a variety of habitats. These nematodes are especially efficacious against insects in the soil and cryptic habitats.

Formulations for Storage and Transport

Although infective juveniles can be stored up to several months in water in refrigerated bubbled tanks, high cost and difficulties of maintaining quality preclude the deployment of this method. High oxygen demand, the sensitivity of some nematode species to low temperature, susceptibility to microbial contamination, and toxicity of antimicrobial agents are factors influencing nematode quality during storage in water. Therefore, nematodes are usually formulated into non-or semi-liquid substrates soon after they are produced.

Factors affecting Nematode Survival in Formulations

Culture method

Nematodes produced *in vivo* have been found to be more stable than those produced *in vitro*. For example, the survival of *S. riobrave* stored in water at 9°C was higher when cultured in *G. mellonella* larvae than in liquid media. However, the mechanisms for these differences have not been explored and may provide clues to physiological factors affecting storage stability. Exposure of nematodes during culture to stresses including temperature extremes, type and quantity of antifoam, and microbial contamination can influence nematode quality leading to reduced shelf-life.

Stored energy reserves

Lipid constitutes about 60% of the dry weight of infective juveniles of entomopathogenic nematodes (Selvan *et al.*, 1993b) and is considered as a major energy reserve. The amount of lipid varies with nematode species and production batches (Grewal and Georgis, 1998) and is influenced by the type and amount of media components, antifoam, temperature, and dissolved oxygen during fermentation. The rate of lipid utilization also differs among nematode species (Grewal, 2000b) and among individuals within a species. Other factors including temperature, oxygen availability, and nematode activity in storage can also influence the rate of lipid utilization and thus survival (Grewal and Georgis, 1998).

Temperature

Most species can withstand some level of desiccation at their optimum reproduction temperature, but desiccation directly at temperature extremes can be lethal. For example, storage of *S. riobrave* at 5°C immediately after formulation in water-dispersible granules resulted in 100% mortality within 2–3 weeks, as compared to less than 20% mortality at 25°C (Grewal, 1998).

Anhydrobiosis

Although anhydrobiosis is an important means of achieving storage stability of entomopathogenic nematodes, comparisons of longevity between

desiccated and non-desiccated nematodes were made only recently. Grewal (2000a) demonstrated that the longevity of desiccated *S. carpocapsae* in water dispersible granules was extended by 3 months as compared to those stored in water at 25°C, whereas the longevity of desiccated *S. riobrave* was extended only by 1 month. These differences in desiccation survival may be related to the differences in the rate of water loss by the infective juveniles. The extension in longevity through anhydrobiosis is metabolically costly. This becomes evident when the longevity of desiccated and non-desiccated nematodes is compared at low temperatures. At 5°C, the longevity of desiccated *S. carpocapsae*, *S. feltiae* and *S. riobrave* in water-dispersible granules was shorter than in water (Grewal, 2000b).

Antimicrobial agents

Microbial contamination can deplete the available oxygen, reduce dispersibility of formulations, cause clogging of spray nozzles, and reduce the acceptability of the product. Although antimicrobial agents can be used to suppress microbial growth, they must be carefully selected as they can reduce nematode survival in the formulations. Furthermore, nematode species differ in their susceptibility to antimicrobial agents. For example, *S. feltiae* and *S. riobrave* are more susceptible to Proxel, a commonly used antimicrobial agent, than *S. carpocapsae*.

Quality Control and Standardization

Maintenance of high viability and virulence during production and formulation forms the backbone of an effective quality control strategy. Viability refers to the percentage of living infective juveniles (compared with dead and non-infective stages) whereas total viable nematodes are the total numbers of living infective juveniles in a suspension. Therefore, motionless nematodes should be either probed or agitated by adding a drop of hydrogen peroxide to facilitate assessments. Over-packing is a method of ensuring minimum total viable nematodes during storage. Virulence is the most important component of nematode quality. Virulence can be measured by several different methods including one-on-one bioassay (Grewal *et al.*, 1999), LC50 (Georgis, 1992), establishment efficiency, and invasion rate (Glazer, 1992). However, assays using multiple nematodes against single or multiple hosts are considered inappropriate for quality control purposes due to host-parasite interactions such as recruitment and overdispersion of natural parasite populations (Grewal *et al.*, 1999). For example, *S. scapterisci* causes 30–70% mortality at 15 infective juveniles per larva and *H. bacteriophora* causes 40–65% mortality at 5 infective juveniles per larva. *G. mellonella* is a preferred bioassay host because it is highly susceptible and is commercially available, thus supply can be assured.

Transport and Handling

Suboptimal storage by the vendor or end-user may be a major factor affecting nematode viability and efficacy. Overall, the nematode species isolated from cold climates tolerate warm temperatures poorly and those from warm localities do poorly at cold temperatures. Desiccated nematodes are more tolerant of temperature extremes than non-desiccated nematodes, and are therefore more stable during transport and handling. Georgis *et al.* (1995) reported that *S. carpocapsae* could be stored for 2 days at 38°C without loss of viability in water-dispersible granules, but not in alginate or flowable gels. Although infective juveniles can withstand short exposure to hypoxic conditions, they do not tolerate hypoxia indefinitely. Also, nematode species differ in their ability to withstand hypoxic conditions. Qiu and Bedding (2000) reported that *S. carpocapsae* infective juveniles incubated in M9 buffer at 25°C under anaerobic conditions, could be revived when returned to aerobic conditions if exposure to anaerobic conditions was not more than 7 days. Refrigerated storage and bubbling air can improve nematode storage stability.

AGROCHEMICALS

20278

51. Microbial Insecticides / Biopesticides

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Now a days, biological means for production of agricultural commodities is gaining lot of importance, among biological means; microorganisms being an integral component of soil ecosystem play a prestigious role by making the soil truly living. The significance of plant growth promotion, rhizosphere competence and the suppression of diseases and pests on the plants is much considered research theme in present days. There is growing interest in the presence of certain naturally occurring, beneficial microorganisms in agricultural lands.

Why we are behind the Biological Means of Production of Agricultural Commodities

Mainly because of the risks with chemical pesticides, the excessive usage of the chemical pesticides results in

1. Indiscriminate use let to the three said R'S (Resistance, Recalcitrant, and Resurgence)
2. Elimination of natural enemies
3. Upsetting the ecological balance
4. Environmental degradation/pollution
5. Beyond the economic
6. Enters food chain

Biopesticide/ Microbial Pesticides

Definition

- Microorganisms which kills, inhibit, compete with pests, including insects or other microorganisms
- The exploitation of disease-causing organisms/ microorganisms to reduce the population of insect pests below the damaging stage is called as microbial control of insect pests

History of Microbial Insecticides

- Aristotle (384 – 322 BC) mentioned that bees suffered from diseases
- Bassi (1835) demonstrated the infectious nature of *Beauveria bassiana* in silk worm
- Le Conte (1873) First advocated the use of diseases as a means of insect control
- Metchnikoff (1879) infected scarab beetles with muscardine fungus
- The term microbial control coined by Steinhaus in 1949

Characteristics of a good microbial insecticide

1. Highly virulent to the targeted organisms
2. Should be stable for long time
3. Virulent should be host specific
4. Neither damage the crop nor beneficial organisms
5. Easily mass culturable and maintainable
6. Ease for mass multiplication
7. Should enhance plant growth

Advantages of Microbial Pesticides

1. Ecofriendly
2. Target the specific insect
3. Easily culturable in the laboratory and inexpensive to produce
4. Slow in developing resistance to pathogen
5. Can control insect in cavities

Disadvantages of Microbial Pesticides

1. Necessity for careful and correct time of application
2. Narrows down its use
3. Pathogen should be in viable condition
4. Difficult in producing some obligate and facultative pathogens
5. Requires favourable conditions
6. Tendency of dead insects remaining attached to the host

ENTOMOLOGY

20242

52. Insect Cuticle Modification: An Unrevealed Mystery

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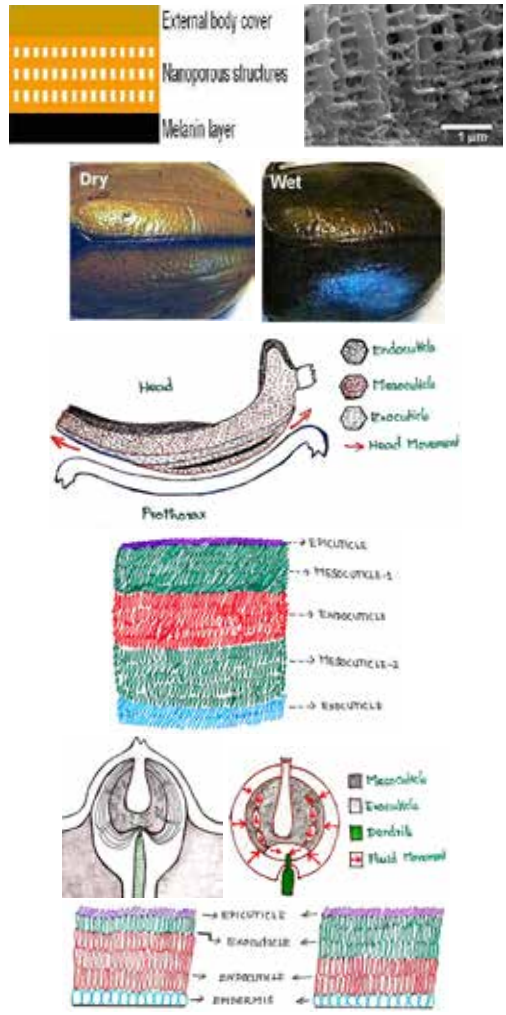
Introduction

Insects possess a cuticle that covers all tissues exposed to the outside world including the body, the fore and hindgut and the luminal side of the tracheae. Cuticle consists of different layers like exocuticle, mesocuticle, endocuticle and epicuticle. Epicuticle again classified as cuticulin layer, polyphenol layer, wax layer and cement layer. Cuticle not only serves as a protective barrier but also it prevents excess water loss, involves in gaseous exchange, acts as food reserve, helps in locomotion and sensing the environment. Insect cuticle exhibits tremendous variations in proportion & hardness of different layers of cuticle based on the function of different parts. Few modifications of cuticle are discussed below:

Dynastus Beetle: For Camouflage and Thermoregulation

Dynastus (Hercules) beetle shows colour differentiation (Green↔Black) according to humidity (80%) of the environment with the help of multiparous layer (fig.1). This colour differentiation (hygrochromic effect) is due to the interference (produced by multilayer) and diffraction (multiple reflections or gratings) of light. Cuticle is modified as a spongy multilayer stack, under a protective wax cover with numerous straight cracks. The multilayer has empty space due to criss-cross structure of strong vertical columns surrounded by horizontal filaments (fig.2). In dry condition, multilayer empty space is filled by air and it produce bright metallic colour (fig.3). When the humidity level increases, water penetrate through the cracks of wax layer and accumulate in empty space which reduces the interference level and causes changes in angle of incidence of light. So, the insect slowly turns from green to black colour (fig.4) in high humidity level.

The purpose of this colour change with humidity is still unveiled. But two hypotheses are given by Hinton and Jarman, 1972. **1. Camouflage:** Greenish colour in day and black colour in night perfectly matches to the tropical environment. **2. Thermoregulation:** Green colour would prevent the beetle from accumulating heat too fast than black colour in day condition. The beetle is still black when the sun rises. So, it will warm up faster.



Pachnoda beetle: for enhancing frictionless movement

Pachnoda (sun beetle) have unusual cuticle layer

pattern in the region of gula (part of ventral head and counter surface of prothorax) than other regions. In gula region, between the epi and exocuticle, two meso and one endocuticular layer (soft & elastic than others) are deposited. Outer surface of gula contain "pad" like sclerotized mesocuticle instead of exocuticle. These layers are not as smooth as other layer of the insect. In *Pachnoda marginata*, gula region parts are permanently contact with each other. So this structure must have resistance to wear and friction. When the head is moved relative to the thorax, the gula glides over the prothoracic counter surface. The mesocuticle pad may functions as fibrous cartilage, which facilitates frictionless movement. Fluid components of the epicuticular wax layer may take on the lubricating function of the synovial fluid.

Melanophila beetles: for sensing the environment

In *Melanophila* (charcoal beetle), both side of metathorax contain a special pit like sense organ which has nearly 70 infrared sensilla. Cuticlar portion involved in conversion of IR into micromechanical force. This conversion process mainly depends on thermo mechanical property of the cuticle region. Harder and stiffer cuticular material (exocuticle) most probably has a lower coefficient of thermal expansion than more elastic and softer cuticle (endocuticle). Sensilla have bulged hemispherical structure, which contain unpigmented, highly sclerotised outer exocuticle and inner layer of mesocuticle (fig:7). Epicuticular region may or may not be present and inner layer of endocuticle is greatly missing. Instead of this endocuticle layer, small tissues like islets are seen in the basal layer of cuticle. Exocuticle is two times harder than the soft mesocuticle. Tip of the mechanosensory dendrite is situated at outer shell of sensilla.

When IR reaches the sensilla, thermal expansion of the cuticle is not uniform. Inner mesocuticle could expand easily but exocuticle could not (fig.8). Ultimately exocuticle restricts the expansion of mesocuticle. Mesocuticle microcavites were filled with water. Due to restriction of exocuticle, pressure increases inside of the sensilla which are transmitted to tip of dendrite by the help of fluid filled in micro cavities.

Myrmecocystus ants: for storing food

Myrmecocystus (honey pot ants) workers store food in their abdomen for future purpose in food available season. In this case cuticle of abdomen alternatively have endocuticle (soft) and exocuticle (sclerite). In normal condition soft portion is folded under the sclerite. While consuming the food, soft portion will expand and act like an air-filled balloon. Endocuticle is more prevalently seen in yellow skin of the abdomen (fig.9). It contains more resilin and responsible for the flexibility. Exocuticle is more prevalently seen in hard dorsal part (black skin) of abdomen, which is rich in chitin and gives rigidity (fig.10).

Conclusion

Cuticular composition differs based upon the habitat and functional characters of the insect. Some insects have well developed layers on the integument, in other insects some layers are reduced or missed. Insects evolve themselves by making changes on the need basis. For instance, to avoid desiccation of eggs, some insects comprise well developed wax layer. In aquatic insects, cuticle of gills region is very thin (1µm) and in some beetles it is very thick (200 µm). In honey bees particularly cement layer is absent. Also, endoparasitic larvae have the ability to respire through cuticle. But the whole modifications were not yet discovered. Thus, modification of cuticular composition deserves more research.

20245

53. Insect Diapause

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The term diapauses refer to the state of arrested growth or reproduction that is typical of many hibernating or aestivating arthropods. Whereas the physiological mechanisms in the diapausing insect are absent in the quiescent. The role of "token stimuli" from the environment in controlling the onset and termination of diapauses, the endocrinology of growth arrests and the biochemical changes are associated with dormancy

Photoperiod

Insect responding to the day length are common in insects showing facultative diapause. Long day period of 8 to 12 hrs induces diapause whereas

short photoperiod or permanent darkness causes uninterrupted growth. In certain Lepidoptera, responding to long day will hibernate as larva. In Dendrolimus larva and moulting are arrested in short days and also, they are susceptible throughout its hibernation period and resumes a week or two after exposing to a long photoperiod. Post diapauses growth is also facilitated by an optimal photo period. But it is less certain whether the larvae are still photo sensitive when fully dormant. The silk worm *Bombox* sp. is exceptional in that, the direction of the response is reversed, short day length prevents and long day lengths induce diapauses. This reversal is associated with a fact that the eggs are influenced by illumination almost immediately after development is resumed in spring. Under natural light conditions therefore the first-generation moths of bivoltine. Strains lay non-

Grapholitha and Metatetranychus are known to take account of day lengths and the dragon fly *Anax* response to changes in day length. Increasing photo periods cause the last stage nymphs to develop promptly, whereas decreasing or constant long photo periods induce diapauses. The role of the dark phase has been demonstrated in *Acronycta* where pupae are only formed if the dark period is longer than 9hr and shorter than 48hrs. In *Bombyx* the type of egg is decided by the condition experienced by the moth during late embryonic development. In *Polychrosis* the pupal diapauses are also largely determined in the egg stage. The red mites laying summer or winter eggs can be switch over to eggs of the opposing types by exposure to an antagonistic photo period. The duration of the sensitive period is also a variable feature.

Role of Temperature, Food and Water in Diapause

Diapause is seldom independent of temperature expect in species like *Antheraea* and *Harrisina* where photoperiod has assumed a dormant rule, diapause is suppressed by high temperature. It has long been recognised that the release from diapauses is often favoured by a long exposure to temperatures. The duration of diapauses is also variable. It is quite transient in the Pentatomid, *Eurydema* disappears after 9 days at a temperature of 8°C, in *Bombyx* 60 days at 5°C, while *Metatetranychus* requires 150-200 days, *Sitodiplosis* sometimes passes up to 12 winters in the soil. There is little evidence that diapause is often brought on by changes in diet. The low water and high fat content of the ripening cotton boll may be some significance in *Platyedra*. the onset of diapause *Eueproctis chrysorrhoea* has been attributed to the age of the foliage.

Many orthopteran eggs, hibernating larvae and adult insects, cannot begin their post diapause growth until moisture has been taken up from their surroundings. But the water uptake will be absent until diapauses development was completed. In Locust and *Chilo*, diapausing egg replaces any water lost by evaporation, there by restoring their turgor but they will not take up sufficient water to stretch the membranes until diapauses has disappeared. But in sawfly *Cephus* absorb water whenever it is available. It absorbs water for 100 or more days of chilling which is needed to end diapause. But if the larvae are chilled without access to water the entire amount can be taken up during the post diapause period

The Inheritance of Diapauses

Strains differs in the character of their diapauses has been recognised in many arthropods. For example, geographical strains of *Tetranychus* respond to slightly different critical photoperiods; the northern Japanese race of *Chilo simplex* Butler has a more intense diapauses than the southern; the West Australian race of *Austroicetes* has a rather higher temperature optimum for diapauses development than the South Australian race. The genetics of diapauses has been examined only in Bombyx. Several genes, both sex-linked and autosomal, affect the voltinism. They have been assigned different "hibernating values" which are recognised by the influence of temperature on the induction of diapauses. By suitable recombination experiments it is possible to prepare a series of stocks showing a graded response to temperature. These range from multivoltines (no apparent diapauses), through bivoltines to univoltines (virtually obligatory diapauses). As all the intermediate grades are represented, it is quite clear that the genotype modifies and shifts the response of the "receptor mechanism" to environmental factors such as temperature.

Diapause in Parasitic Insects

The synchronous development of insects and their parasites is achieved in different ways. The eggs of *Diplazon fissorus* Grav. (Ichneumonidae) are deposited in young syrphid larvae, after hatching, the first instar larvae undergo no further development until the host forms the puparium. In the multivoltine syrphid, *Epistrophe balteata* Deg. the delay lasts only a few days, but in the univoltine species *E. Bifasciata* Fabricius which has nine-months larval diapauses, the parasite also overwinters as a young larva. As the parasite larvae are very rapidly activated or immobilised when transplanted into the appropriate hosts, this state of arrest resembles "quiescence" rather than diapauses. In certain Diptera which normally overwinter as diapausing third instar larvae, form

their puparia prematurely in autumn when invaded by hymenopterous parasites. In-plantation experiments with the ichneumonid *Diplazon pectoratoriius* (Thunb.) showed induced pupation is a result of the direct action of some substance secreted by the parasite either by saliva or the moulting hormone which diffuses out through the body wall of the parasite.

The Hormonal Regulation of Diapauses

In Bombyx the type of egg is decided by a secretion from the suboesophageal ganglion where in the presence lays diapause eggs and in the absence lays non-diapausing eggs. The moulting and growth are controlled by an endocrine system which includes the brain a prothoracic gland. In *Platysamia*, failure in neurosecretory cells prevents the activation of the prothoracic glands. Reproductive diapauses in Dytiscus, *Leptino tarsa* and anopheles is due to the absence of gonadotrophic hormones which is required for the full maturation of ovaries.

Conclusion

The diapause is the week stage in the insect developments. This opens up new area of pest management by interrupting the growth and development of the insects.

20246

54. Pesticide Management Bill, 2020

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A Farmer with Pesticide near a Field Photo: Meeta Ahlawat/CSE

The Minister of Agriculture and Farmers Welfare, Mr. Narendra Singh Tomar, on March 23, 2020 introduced The Pesticide Management Bill, 2020 in Upper House. It regulates the manufacture, import, market, storage, distribution, use, and disposal of pesticides, in order to ensure the safe availability and usage of pesticides and to compensate the loss caused to the farmers. It minimize the risk associated with pesticides and impact on humans, plants, animals and environment due to toxicity. The Bill seeks to replace the Insecticides Act, 1968 that currently regulates the pesticide usage in our country.

Characteristics of the Bill

- **Pesticide Particulars**: It will help the farmers by providing them with all the information's openly as statistical figures in digital format and in all vernacular languages. All information will be available about the pros and cons of pesticides, the risk and alternatives and their effects.
- **Reimbursement:** The Bill has a unique feature in the form of a provision for funds in case there is any loss to farmers because of the low quality of pesticides. Central Government will provide the compensations in case of emergency.
- **Natural Pesticides:** The Bill plans to promote growth of natural pesticides such as neem formulations.
- **Registration of Pesticide Manufacturers:** It will ensure that all pesticides have to be registered by registration committee, once it is passed. The advertisements of pesticides will be regulated and promoted so there should be no deceiving and fair promotion of pesticides will be done.
- **Pest and pesticide:** The Bill define a pest as any species of animal, plant, or pathogenic agent that is unwanted, or cause harm to plants, humans, animals, and the environment. A pesticide is any substance of chemical or biological origin intended for preventing or destroying any pest including insects, rodents, fungi and weeds that cause

harm in agriculture, industry, public health, pest control operations, or for ordinary use.

- **Central Pesticides Board:** The central government will constitute the Central Pesticides Board in order to advise the central and state governments on scientific and technical matters arising under the Act. It will also advise the central government in formulating standards, rules and regulations for: (i) pesticide manufacturers, laboratories, and pest control operators, (ii) working conditions and training of workers, and (iii) recall and safe disposal of pesticides. The Board will also frame convention to deal with pesticide poisoning cases.
- **Registration of pesticides:** Certificate of Registration will be necessary for the pesticide from the Registration Committee. The Central Government will constitute the committee, and will: (i) specify the conditions that should be followed for granting the certificate and issue certificates, (ii) periodically review the safety and efficacy of registered pesticides, and amend or cancel their certificates in case of offence, and (iii) notify substances which have same chemical or biological action as a pesticide.
  - **Registration criteria:** The Registration Committee will assess the information about the pesticide factors submitted in the application such as safety, application, efficacy, necessity, end-use, risks, and availability of safer alternatives. It will not register a pesticide if the applicant submits wrong information, or if the maximum residue limits for the pesticide on crops and commodities are not specified under the Food Safety and Standards Act, 2006. It may not register the pesticide if there is scientific uncertainty regarding its pros and con, and threats of some serious and irreversible damage caused to human health, plant health, or the environment.
- **Licenses:** License from the Licensing officer will be necessary for the person seeking to manufacture, distribute, exhibit for sale, sell, or stock pesticides, or undertake pest control operations, who is appointed by the state government. Once the registration certificate for a pesticide is issued, the applicant must obtain a license from the office within the specified period of time, failing which the certificate will not be issued or it may be cancelled. License is not required for selling or storing standard use pesticides (intended for use only in households, offices, and similar premises), which may be notified by the federal government.
- A person's license will be abrogating if he is indulged in an offence under the Act. It can also be abrogate or cancelled if he: (i) violates the conditions under which the license was granted, (ii) breach the provisions of the Act or the rules made under the Act, or (iii) had submitted wrong or misleading information to obtain the license
- **Prices:** Central government will consider it necessary or expedient to secure the distribution and availability of pesticides at cost effective prices. For that, it may constitute an authority to regulate their price in an economic manner.
- **Prohibition on certain pesticides:** The central and state governments may, by notification, prohibit the production, distribution, sale, or use of a pesticide or a specified batch in an area, up to a specified period of time. Pesticides can be prohibited if: (i) they pose high risk to, or can adversely affect human health, plants, or the environment, or (ii) they pose a barrier in international trade market of agriculture commodities.
- **Pesticide inspector:** The central and state governments may, by notification, appoint pesticide inspectors for certain areas. A pesticide inspector can: (i) enter and search a premises or vehicle if he suspects break of an any offence or wants to check the area, (ii) grab any document, material, or stock of pesticides that is irrelevant and may file the case, (iii) send samples of pesticides for testing, reporting and analysis to laboratory, and (iv) restrict the sale, use, distribution, or disposal of pesticides with the Executive Magistrate's approval for a period of up to 60 days or until the receipt of the sample test reports come.
- **Offences:** Manufacturing, importing, distributing, selling, exhibiting for sale, transporting, storing of pesticide, or undertaking pest control operations, without a license or certificate will be punishable for person with an imprisonment of up to three years, or a fine of up to Rs 40 lakh, or both. Persons using standard pesticides *i.e.,* in their own household, kitchen-garden, or land under their own cultivation are not liable for prosecution for any offence under the Bill.

20248

55. Meteorological Aspects of Locust Control

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Introduction

Locust are any of a group of insects (Acrididae; Orthoptera) that are dispersed globally, the common name mostly mentions the assembly of short-horned grasshoppers that every so often increase significantly in numbers and migrate distances in devastating swarms covering hundreds of square kilometers. In North America the names locust and grasshopper are used for acridid. Cicadas (order: Homoptera) too could be called locusts, the 17-year "locust" being the 17-year periodic cicada. The grouse (or pygmy) locust is a member of the family Tetrigidae (*see* pygmy grasshopper). About 15 cycles of locust outbreak is recorded in India since 19th century.

Some of the important locust species are:

- *Desert locust*: Schistocerca gregaria.
- *Migratory locust*: Locusta migratoria.
- *Bombay Locust*: Nomadacris succincta formerly known as Patanga succincta.
- *Australian plague locust*: Chortoicetes terminifera.

Desert locust having the capability of inter-continental migration is the most devastating among them. Their habitat extends from Mauritania across the Sahelian countries of gulf area and India from Iran to Tanzania causing serious devastations. This represents an area of 29 m. sq. kms.

A phase theory was propounded by S. Pradhan to explain the sporadic appearance and disappearance of locust swarms. According to the theory, a plague species has two phases: one solitary and the gregarious. A solitary-phase nymph, for example, adjusts its coloration to match that of its surroundings, does not collect in groups, has low metabolic and oxygen-intake rates, and is sluggish. A gregarious-phase nymph, on the other hand, has black and yellow or orange coloration in a fixed pattern, gathers in large groups, has high metabolic and oxygen intake rates, and is active and nervous. The theory states that periodic phase changes follow periods of climatic extremes. The Phase changes depends upon successful breeding, abundant rainfall, congenial temperature, favourable wind and higher humidity.

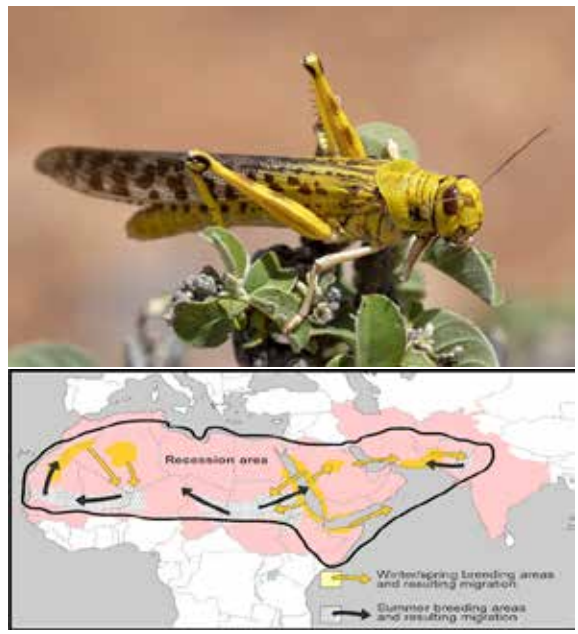

FIG 1 AND 2: Desert locust (source https://www.carbonbrief.org/) and Migration pattern of Desert Locust (source: http://www.fao.org/) respectively

Meteorological Aspects of Locust Control

Enormous size of locust swarms with their high feeding rate makes them difficult to control once the infestation starts. Hence monitoring of the climatic conditions in the major breeding areas (places of origin) is of vital importance. (Pedgley, 1981) developed a desert locust forecasting manual which states that,

- Temperature between 20-40°C are limits for survival of the eggs, nymphs and adults of desert locust.
- Maturation of adults requires temperature of 26-37°C with relative humidity of 45-80%.
- Besides these the upper circulation and wind are of vital importance.

Rainfall and Locust Activities

Study of Indo-Pak region by (Chandra, 1985) revealed interesting relations.

- Scanty monsoon rainfall in preceding year of plague: the monsoon drought of 1963, 1972, 1974, 1982, 1985 in Rajasthan preceded

subsequent plague years in 1964, 1973, 1975, 1983, 1986 in Indo-Pak regions.

- Normal or heavier rainfall both in monsoon season and winter spring season in the first year of the plague which is responsible for initial buildup of locust population and initiation of upsurge.
- Spring generation of swarms bred in eastern Arabia, Iran and/or Baluchistan had invaded Indo-Pak summer breeding areas during May-July in the starting year of plague and got established under favourable monsoon rainfall situation.
- Anomalies in seasonal occurrence of weather systems (like tropical cyclones) may result in the transfer of spring generation swarms into unsuitable habitats as happened in 1946 and 1955.

Locust Monitoring in Breeding Areas

Effective control of desert locust requires proper monitoring at the breeding sites so that it can be checked from the plague development. Collective effort is needed as the isolated effort if not found to be an effective system of monitoring. Criteria to be monitored are:

- Determination of favourable temperature (both maximum and minimum temperature), relative humidity for locust breeding, survival and flight.
- Routine observation of required weather parameters.
- Preparation of daily weather charts.
- Determination of critical period using the charts.
- Carrying out effective control measures at proper stage.

Remote Sensing for Locust Forecasting in India

FAO has adequate proof that satellite images would be harnessed to map out the areas of rainfall and resultant vegetative growth. Satellite centre and field headquarters of locust warning organisation was established in Jodhpur (1979) with major objective to have understanding on the inherent characteristics of various satellite data relating to general environment of desert locust. The lab started functioning in 1980 with cooperation of FAO and National Remote Sensing Agency (NRSA), Hyderabad.

The phase-I (1980-84) of the project was aimed at description of main landscape features, topography and hydrological features. Delineation of water bodies and hydrological features. Evaluation and comments on difference in image tone characteristics between acquisition data and information extraction. Identification of areas where locusts and grasshoppers are likely to be found in the areas covered by the images (*e.g.*: high, medium, low, very low and no potential).

The Phase-II became operative in 1985 with financial assistance from government of Netherland and active support from Regional Remote Sensing Service Centre (RRSSC), Department of space, GOI (1988).

The satellite data are analysed digitally by Global Vegetation Index (GVI), soil moisture index (SMI) and Normalized Difference Vegetation Index (NDVI) and correlation studies with satellite data of 1979-1987 were done. Interpretations were made both by digital and visual means.

Locust Intelligence and Warning Establishments

- Permanent locust warning organisation (LWO) was established in 1939 with the main aim to keep vigil by means of effective survey and study on population fluctuations and tendencies of phase transformations all over the possible breeding regions of this insect and issue periodic warning to all concerned.
- LWO has 5 locust circle offices, 23 locust outposts, Field station for investigation on locusts (FSIL) at Bikaner and a remote sensing lab at Jodhpur.

Conclusion

Isolated effort by one country cannot be effective as the breeding belt extends through international boundaries from central India to eastern Africa. There have been from many decades, International Locust Centre at London. Trained Indians have been deported from time to time to Iran, Arabia and other countries to carry out locust control.

References

Pedgley, D.E. (1918). Desert Locust Forecasting Manual. *Centre for overseas pest research*. **1**; 268-269.

Chandra, S. (1985). The development of Desert Locust outbreak in Indo-Pakistan region during 1983 - a case study. *Plant Protection Bulletin, India*. **37**(3); 7-12.

20257

56. Mites of Tea and their Management

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Introduction

Tea is an important beverage crop worldwide. The Tea plantations are being affected by many arthropod pests, viz. insects and mites. The mite pests play a major role in reducing the yield and quality of the tea leaves. There are a variety of mites known to be associated with tea plants, the major among them are Red Spider mite, Scarlet mite, Purple mite, Pink mite and Yellow mite.

Red Spider Mite - *Oligonychus coffeae* (Tetranychidae: Acari)

The Red Spider mite is one most destructive pests of tea plantations. It was first discovered during 1886 in Assam, India and it is now widely present in all the tree growing regions of India. The infestation by this mite may result a crop loss of about 17% to 46%.

Symptoms and Nature of Damage

Both nymphs and adult suck the sap from the slightly matured leaves. Feeding by nymphs and adults causes the leaves to become bronzed, dried and crumpled. Finally, the leaves get desiccated and fall off. When severe infestation occurs, it causes webbing on leaf surface and ballooning symptom *i.e.* under high population densities, these mites move to tip of the plants using the silk strands to form ball like mass, which will be blown by the winds so that the mites get dispersed to new leaves or nearby plants.

Biology

Eggs are reddish, spherical and has a small filament and are laid singly along veins and mid ribs. The egg period is 4 - 6 days. Nymph: Immediately after hatching, the mites will pass through a larval stage with six legs. Then there are two nymphal stages namely, protonymph and deutonymph. Each developmental stage is followed by a quiescent stage. The nymphal period is 6 – 8 days. Adults are bright, crimson red anteriorly and dark purplish brown posteriorly.

Scarlet mite: *Brevipalpus californicus* (Tenuipalpidae: acari)

Scarlet mite is an important pest in tea plants. It is distributed all over India, feeding on Citrus, Coffee, Rubber and *Parthenium*, confers a crop loss of 8 to 17 %.

Symptoms and nature of damage

Large number of mites is seen near the petiole and along in the midrib regions of mature leaves. Mites gets congregated on the under surface of mature tea leaves, feeding by scarlet mites leads to brown discoloration of leaves.

Biology

Eggs are bright red eggs laid on the under surface of leaves. The egg period is 6 - 13 days. Nymphs are red in color, like that of Red spider mite, this also has a six-legged larval stage. The nymphal period is 7 – 10 days. Adults are flat, elongated and oval and scarlet in color with black marks dorsally. Adults can be seen with naked eyes. Total life cycle gets completed in 30 – 36 days.

Purple mite: *Calacarus carinatus* (Eriophyidae: acari)

Purple mite is widely distributed all over India. The host range include Tea, Coffee, Chillies and Beans.

Symptoms and nature of damage

Purple Mites feed on the under surface of mature leaves. The feeding by this purple mite causes brown or coppery brown or smoky discoloration of leaves.

Biology

Eggs are sub hemispherical, transparent and laid singly on the under surface of mature leaves. The egg period is 3 - 5 days. Nymphs undergo three moults. The nymphal period is 3 – 6 days. Adults are very small and spindle shaped dark purple in colour with five longitudinal white waxy ridges on the dorsal side.

Pink mite or orange mite: *Acaphylla theae* (Eriophyidae: acari)

Pink mite or orange mite is an important pest in South-Indian tea plantations and also it is widely distributed all over India. The host range include Tea, Coffee, Chillies and Beans.

Symptoms and nature of damage

Both nymphs and adults suck the sap from young foliage. Continuous feeding and desaping of leaves

by Pink mite causes the leaves turn pale and curl upward. Under severe infestation, the leaves become leathery and brown in color. Damages are often to top 10-15 cm tender leaves. Assam type of tea is susceptible to pink mite.

Biology

Eggs are laid singly on the under surface of the young leaves. The egg period is 2 - 3 days. Nymphs are white in color. The nymphal period is 6 – 9 days. Adults are Minute, orange colored and carrot shaped.

Yellow mite: *Polyphagotarsonemus latus* (Tarsonemidae: acari)

Yellow mite is also referred to as broad mite. It is distributed in countries like India, Europe, U.S.A., Bangladesh, Malaysia, Sri Lanka & Philippines. It is a polyphagous pest and feeds on Tea, Cotton, Jute, Coffee, Tomato, Potato, Chillies, Rubber, Beans, Pepper, Avocado and Citrus.

Symptoms and nature of damage

The damage is restricted to top two to three leaves and the bud. Leaves become rough and brittle. Corky line or patches appear on the lamina. Internode gets shortened, stunted and deformed.

Biology

Eggs are colorless, oval shaped, translucent and speckled with numerous circular whitish tufts. The incubation period of eggs is 2 to 3 days. Nymphs are white in color. The nymphal period is 2 – 3 days. Adults are oval, broad and yellowish in colour. Females are bigger than males. The total life cycle gets completed in seven days in normal weather conditions.

Management of Tea Mites

Follow good agricultural practices (gap)

a) Use shade and mulching to increase humidity, as mites are favored by dry and hot weather conditions.
b) Spraying foliage with water (or water mixed with a little soap).
c) Avoid movement from mite infested part to the other parts of the field.
d) Use less pesticides (insecticides and fungicides) to protect beneficial organisms (natural enemies).
e) Pruning greatly reduces the population of scarlet mites.
f) Remove the alternate host plants that provide food for spider mites.

Encourage the natural enemies to reduce the mite population

a) Predatory mite (Phytoseiulus, Amblyseius, Typhlodromus and Mexecheles),
b) Tiny black lady beetle (Stethorus spp.),
c) Spiders,
d) Chrysoperla spp., to keep mite population under check.
e) Application of spore suspension of Paecilomyces jumosotroscus (UPASI strain) Mycomihc @ 1.5 kg/ha

Spray any of the following insecticides

Azadirachtin 5% @ 0.5 ml/L or Fenpyroximate 5 EC @ 0.75 ml/L or Dicofol 18.5 EC @ 5 ml/L or Fenazaquin 10 EC @ 2.5 ml/L or Phosalone 35 EC @ 2 ml/L or Profenofos 50 EC @ 2 ml/L, Propargite 57% EC @ 2 ml/L or Fenpropathrin 30 EC @ 0.4 ml/L or Hexythiazox 5.45 EC @ 0.75 ml/L or Ethion 50 EC @1 ml/L for effective control of mites.

References

Hazarika, L., Bhuyan, M., & Hazarika, B. (2009). Insect Pests of Tea and Their Management. Annual review of entomology. 54: 267-284.

Mukhopadhyay, A., Das, S., & Basnet, K. (2018). Pests of Indian Tea Plantations. 10.1007/978-981-10-8687-8_20.

Rao, G. N. (1970) Tea pests in Southern India and their control, PANS Pest Articles & News Summaries, 16(4): 667-672.

20262

57. Plant Diseases Cause by Arthropod Vectors

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Introduction

There are several diseases causes by the arthropods. Generally sucking pest are spread more viral disease. Major arthropods vectors are aphids, hoppers, whiteflies, thrips, mealy bug, mite and some beetle (Nault, 1997).

1. Aphids

Aphids are soft bodied insects belonging to the order homoptera and carrying viruses on their mouthparts may have to probe for only a few seconds or minutes before the plant is infected. Aphid having three stage of their life cycle so called hemimetabolous insect also parthenogenesis reproduction observed. In the world, there are different species of aphid available which spread the several diseases. Some major species are *aphis craccivora, aphis gossypii, myzus persicae etc.* (Sorensen, 2009). list of viral disease which is spread by aphid given below (Table 1);

TABLE 1: Viral disease transmitted by Aphids

Disease	Causative organism	Transmitted by
Barley yellow dwarf	Barley yellow dwarf virus	Acyrthosiphon dirhodum; Sitobion avenae
Ragi mosaic	Ragi mosaic virus	Rhapalosiphum maidis
Cowpea mosaic	Cowpea mosaic virus	Aphis craccivora
Bean common mosaic	Bean common mosaic virus	Acyothosiphon pisum; Aphis fabae; Myzus ppersicae
Bean yellow mosaic	Bean yellow mosaic virus	Acyothosiphon pisum
Beet western yellows	Beet western yellow virus	Myzus persicae
Soybean mosaic	Soybean mosaic virus	Aphis glycines
Soybean mild mosaic	Soybean mild mosaic virus	Myzus persicae
Pea enation mosaic	Pea enation mosaic virus	Acyrthosiphon pisum
Sowthistle yellow vein	Sowthistle yellow vein virus	Hyperomyzus lactucae; Macrosiphum euphorbiae
Peanut stripe (PSTV)	Peanut stripe virus	Aphis craccivora
Peanut rosette	Peanut rosette virus	Aphis craccivora
Sugarcane mosaic disease	Sugarcane mosaic virus	Aphis gossypii; Aphis maydis
Banana bunchy top	Banana virus 1 or Musa virus 1	Pentalonia nigronervosa
Banana mosaic	Cucumber mosaic virus	Aphis gossypii; Myzus persicae
Papaya mosaic	Papaya mosaic virus	Aphis gossypii; Aphis malvae
Citrus tristeza	Citrus tristeza virus	Toxoptera aurantii; Toxoptera citricidus
Chilli mosaic	Tobacco mosaic virus	*Aphis gossypii* glover; *Myzus persicae*
Cucumber mosaic disease	Cucumber mosaic virus	Myzus persicae
Potato leaf roll	Potato virus A	Myzus persicae
Rugose mosaic of potato	Potato virus X	Myzus persicae
Potato leaf roll	Potato virus A	Myzus persicae
Katte disease of cardamom	Cardamom mosaic virus	Pentalonia nigronervosa
Tobacco mosaic virus	Tobacco mosaic virus	Myzus persicae

2. Hoppers

The hopper, as we refer collectively to the leafhopper, plant hopper and tree hopper were the first insect proven to be vectors of plant viruses. The hopper rank second to the aphids and their sternorrhyncha relatives in the number of viruses transmitted (Nault and Ammar, 1989). Circulative and propagative type of viruses transmitted by this vector, list of viral disease which is spread by hopper given below (Table 2);

TABLE 2: Viral disease transmitted by Hoppers

Disease	Causative organism	Transmitted by
Leaf hoppers		
Rice dwarf	Rice dwarf virus	Nephotettix cincticeps; N. virescens; N. nigropictus; Recilia dorsalis
Tungro	Rice tungro spherical virus; Rice tungro bacilliform virus	Nephotettix virescens; Nephotettix impicticeps
Plant hoppers		
Rice grassy stunt	Rice grassy stunt virus	Nilaparvata lugens
Rice ragged stunt	Rice ragged stunt virus	Nilaparvata lugens
Rice hoja blanca	Rice hoja blanca virus	Tagosodes orizicol; Sogatodes oryzicola
Rice stripe	Rice stripe necrosis virus	Laodelphax striatellus
Maize mosaic	Maize mosaic virus	Peregrines maidis
Maize rough dwarf	Maize rough dwarf virus	Laodelphase striatellus
Tree hoppers		
Pseudo curly top disease of tomato		Micrutalis malleifera

3. Whiteflies

Whiteflies (Aleyrodids) are found in both tropical and sub-tropical regions. Whitefly prefer the undersides of young leaves and have the capacity for rapid reproduction when conditions are favourable. When leaves are disturbed in infested crops, clouds of white flying insects indicate their presence. They damage plants by sucking the plant's sap causing reduced growth, stunting and yield reduction. Honeydew secretions from whitefly can result in the development of sooty mould on produce. The silver leaf whitefly injects toxic saliva while feeding, causing silvering of leaves in cucurbits and irregular ripening and blotching in tomato fruit. Begamovirus, crinivirus and closterovirus transmitted by whitefly (Table 3). The whitefly is also an important vector or carrier of viruses which result in enormous economic losses in vegetable, grain and fibre crops worldwide (Costa, 1976).

TABLE 3: Viral disease transmitted by Whiteflies

Disease	Causative organism	Transmitted by
Mungbean yellow mosaic	Mungbean yellow mosaic virus	Bemisia tabaci
Soybean yellow mosaic	Soybean yellow mosaic virus	Bemisia tabaci
Mungbean yellow mosaic	Mungbean yellow mosaic virus	Bemisia tabaci
Cotton leaf curl	Cotton leaf curl virus	Bemisia tabaci
Papaya leaf curl	Papaya leaf curl virus	Bemisia tabaci
Yellow vein mosaic virus of okra	Yellow vein mosaic virus	Bemisia tabaci
Chilli leaf curl	Tobacco leaf curl virus; Tomato yellow leaf curl virus	Bemisia tabaci
Tomato leaf curl	Tomato leaf curl virus	Bemisia tabaci
Tomato yellow leaf curl	Tomato yellow leaf curl virus	Bemisia tabaci
Bitter gourd yellow mosaic	Bitter gourd yellow mosaic virus	Bemisia tabaci
Cassava mosaic	Cassava mosaic virus	Bemisia tabaci
Tobacco leaf curl	Tobacco leaf curl virus	Bemisia tabaci

4. Thrips

Thrips belonging to the order thysanoptera that are known to be vectors of plant viruses. Thrips transmit plant viruses in the Tospovirus, Ilarvirus, Carmovirus, Sobemovirus and Machlomovirus genera (Table 4). Once infected at the larval stage, adult thrips usually transmit tospoviruses for life. Transmission to the plant hosts occurs when thrips feed (Jones, 2005).

TABLE 4: Viral disease transmitted by Thrips

Disease	Causative organism	Transmitted by
Peanut bud necrosis virus (PBND)	Tomato spotted wilt virus	Thrips palmi; Franklinelli schlutzi
Tomato spotted wilt	Tomato spotted wilt virus	Frankliniella occidentalis
Tobacco streak virus	Tobacco streak virus	Scirtothrips dorsalis; Frankliniella schultzi; Thrips tabaci

5. Mealy bug

Mealy bugs are insects in the family Pseudococcidae, unarmored scale insects found in moist, warm habitats. Many species are considered pests by some humans as they feed on plant juices of greenhouse plants, house plants and subtropical trees and also act as a vector for several plant diseases (Table 5). Some ants, however live in symbiotic relationships with them (Sharma and Pati, 2013).

Table 5: Viral disease transmitted by Mealy bug

Disease	Causative organism	Transmitted by
Cacao mottle leaf	Cacao mottle leaf virus	Planococcoides citri
Cacao swollen shoot	Cacao swollen shoot virus	Planococcoides njalensis

6. Beetles

Beetles belonging to the order coleopteran also called holometabolus insect. A number of plant viruses are now recognized as being transmitted by leaf-feeding beetles (Table 6). They are particularly numerous in temperate and tropical areas of the world. Beetle transmissible viruses have many similar properties. All are polyhedral RNA viruses about 25 to 30 nm in diameter. They are easily transmitted mechanically, relatively stable and highly antigenic (Fulton *et al.*, 1987).

TABLE 6: Viral disease transmitted by Beetles

Disease	Causative organism	Transmitted by	Type of insect
Rice yellow mottle	Rice yellow mottle virus	Chaetocnema pulla	Chrysonelid beetles
Southern bean mosaic	Southern bean mosaic virus	Ceratoma trifurcata	Bean leaf beetle

7. Mites

Member of the families Eriophyidae and

Tetranychidae transmit several viruses (Table 7). The mite retains infectivity through molts and may remain infective 6-9 days after removal from the infected plants (Oldfield, 1970). The mite normally infective as a nymphs not as a adults. Eriophyids have been capable of transmitting viruses of monocots and viruses of dicoats.

TABLE 7: Viral disease transmitted by Mites

Disease	Causative organism	Transmitted by
Wheat spot mosaic	Wheat spot mosaic virus	Aceria tulipae
Wheat streak mosaic	Wheat streak mosaic virus	Aceria tulipae
Ryegrass mosaic	Ryegrass mosaic virus	Abacarus hystrix
Pigeonpea sterility mosaic	Pigeon pea sterility mosaic virus	Aceria cajani
Cherry mottle leaf	Cherry mottle leaf virus	Eriophyes inaequalis
Peach mosaic	Peach mosaic virus	Eriophyes insidiosus

References

Sorensen J.T., (2009). Aphids. In Resh, Vincent H.; Carde, R.T. (eds.). Encyclopedia of insects (2 ed.) Academic Press. Pp. 27-31.

Nault L.R., (1997). Arthropod transmission of plant viruses- a new synthesis. *Annals of the Entomological Society of America*. 90(1): 521-541.

Fulton J.P., Gergerich R.C. and Scott H.A., (1987). Beetle transmission of plant viruses. *Annual Review of Phytopathology*. 25:111-123.

Nault L.R. and Ammar E.D., (1989). Leafhopper and planthopper transmission of plant viruses. *Annual Review of Entomology*, 34:503-529.

Oldfield G.N., (1970). Mite transmission of plant viruses. *Annual Review of Entomology*. 15:343-380.

Sharma A. and Pati P.K., (2013). First record of Ashwagandha as a new host to the invasive mealybug (*Phenacoccus solenopsis* Tinsley) in India. Entomological News. 123(1): 59-62.

Jones D.R., (2005). Plant viruses transmitted by thrips. *European Journal of Plant Pathology*, 113:119-157.

Costa A.S., (1976). Whitefly transmitted plant diseases. *Annual Review of Phytopathology*, 14:429-449.

20269

58. Impact of World Lockdown on Insect Pests and their Management

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Introduction

The corona virus disease (COVID-19) caused by severe acute respiratory syndrome corona virus-2 (SARS-Cov-2). This outbreak of disease was first noticed in Wuhan city of China and later it had spread to most of the countries in the world. It is a contagious disease spreading through the droplets of cough and sneezes of infected people. In order to prevent the spread of the disease most of the countries in world-imposed lockdown and also closed all the international borders. Insect pests are a major cause of economic losses to the agricultural crops around the year in all parts of the world and subject of enormous control programs to reduce their impact. The global shutdown due this pandemic may have significant influence on the insect pests and also on the management practices to combat them.

Impact of Lockdown on the Insect Pests

The world lockdown showed both positive and negative impacts on insect pests. In many countries of the world the lockdown was enforced from the mid of the march of 2020. This period from the mid of the march where most of growing field crops were attaining full maturity and are ready to harvest. The farmers faced problems like shortage of the labor and harvesters for harvesting crop than the insect pests. At harvesting stage only few insects were noticed, the control measures like application chemical pesticides are not recommended due to residue problem. In case

of the seasonal vegetable crops and horticultural crops suffered pest outbreaks because during initial (21days) lockdown due to restrictions on the movement these crops remain unattended. The necessary cultural practices like weed removal are not carried where they act as alternate hosts for insects' pests. The major plant protection measures include pesticide spraying operations were not carried due to restrictions imposed under lockdown.

Impact of Lockdown on the Storage Pests

The major crops rabi crops like wheat, maize and vegetable crops like potatoes attained full maturity. The harvested produce remained at fields and home due to lack of market (mandi) to procure the produce. Storing of the produce is major problem faced by farmers due to lack of proper storage facilities at home and fields for storing bulk amount of the produce. Storing the produce for longer duration and longer period of time attracts the pests. This pest outbreak under storage conditions causes considerable losses both qualitatively and quantitatively. The already stored produce in the warehouses may suffer due to pest attack. This pest outbreak may be due to lack of pest monitoring and pest control activities in ware houses.

Impact of Delayed Sowing on Insects Pests under Lockdown Conditions

The sowing of the summer crops will be started in the months of the April. Mostly in Indian situation farmers go for growing of vegetable crops. The farmers are unable to access the seeds and other agricultural inputs during the first lockdown (21 days), so most of the farmers do not go for cropping. During extended lockdown (up to May 3) there is exempt from shutdown to agricultural inputs and other essential commodities. A few of farmers gone for sowing of vegetable crops, delayed sowing of crop may either encourage some pests or discourage the pest development on crops.

Impact of Lockdown on Biological Control of Insect Pests

The bio-control agents like parasitoids, predators and entomopathogens play a key role in reducing the levels of pests. The bio-control of insect pests is one of the important tactics in integrated pest management. The global shutdown resulted in closure of bio-control agent production units, so there is no supply of bio-control agents to farmers. This lack of supply of bio-control agents may result in the pest out breaks.

Impact on Insect Pests due to Scarcity of Labor under Lockdown

The availability of the farm laborers became scarce during this lockdown, so mostly family labor may engage in field operations. The summer crops sown during the month of the April mostly will be in the vegetative stage, which attracts the most insect pests. In order to reduce the pest load on the crop the farmer has to go for pesticide spraying. Under this lockdown the scarcity of the labor may result in reduced number of sprayings.

Impact on Insect Pests due to Poor Decision Making by Farmers

Generally, farmers seek the advice from the agricultural experts regarding pest problems in the field. Under this lockdown conditions there is no direct interactions between the farmers and agricultural experts to give advice on pest management practices. Finally, farmer makes own decisions for pest management based upon his traditional knowledge, either it may be fruitful or it may be a disaster. In most of the cases the success of pest management comes when farmer follows the expert advice. So, the poor decision making by farmers may result in increased pest out breaks.

Impact of Reduced Pollution due to Lockdown on Insect Pests

Air pollution potentially could influence the insects directly by inducing changes in fecundity, relative growth rate, and other developmental and reproductive parameters or indirectly affecting the insects by inducing changes in the plant chemistry by the pollutant. Studies on the air pollution impacts on the herbivorous insects are limited. However, there were the reports of the increased infestation in the polluted locations. The increased whitefly and aphid infestation have been observed on a range of crop and wild species in the industrial area of Noida, Delhi and maize stem borer shows abnormally high levels of the outbreak in SO_2 polluted areas of the Vaal triangle in South Africa (Bell, 2000). These polluted environment decreases the activities of predators like birds which keeps pests under control.

Impact of Natural Enemies Under Lockdown Conditions

Natural enemies are the biological control agents include predators, parasitoids and pathogens; they keep insect pests under control. The air pollutants have differential effects on natural enemies. The reduced air pollutants in environment under lockdown conditions show positive effect on the natural enemies. Egg predation, mainly by syrphid larvae and zoophagous bugs was higher at relatively clean site (55.3%) than at polluted sites (22.2%). Total mortality caused by natural enemies was higher at clean sites (93.7%) than at the polluted sites (79.4%) due to high predation rates (Elena *et al.*, 2000).

Impact of Lockdown on Exotic Pests

Exotic pests are non-indigenous species accidently introduced into the native countries through the transport, movement of people and imports of agricultural commodities. These exotic pests cause enormous damage to crops because of absence of the natural enemies in the introduced environment. To prevent the spreading of this pandemic disease all the international borders sharing with other countries are closed. In order to prevent the transmission of the disease, the movement of the people and import of all commodities from international borders are closed. This restriction in movement of people and agricultural commodities along the international as well as interstate borders will prevent the introduction of invasive pests.

Conclusion

This world lockdown has both positive and as negative influences on insect pests. The pest outbreaks under these lockdown conditions can be managed by looking solutions to available problems. Utilization of new technologies like automated pest monitoring through smart pest traps, the grower can get information about pests through web-based application and usage of robotics and drones for pesticide spraying is very helpful under labor scarcity conditions. The central and state governments should come forward and encourage new startups providing these services and also educate farmers about these new technologies in pest management. However, lockdown has some negative impacts on pest management but protection of human population from this disease is more important than the economy of the country.

References

Bell J. N. B. 2000. Effects of air pollution on herbivorous insects. In: Yunus M., Singh N., de Kok L.J. (eds.) Environmental Stress: Indication, Mitigation and Eco-conservation. Springer, Dordrecht.

Chen, F. J., Wu, G. and Ge, F. 2004. Impacts of elevated CO_2 on the population abundance and reproductive activity of aphid, *Sitobion avenae* Fabricius feeding on spring wheat. *Journal of Applied Entomology*. 128: 723-730.

20271

59. Concepts of Integrated Pest Management

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IPM is mostly based on ecological principles and also involves integration and synthesis of different components into pest management. The basic elements in any IPM programme are natural control, sampling, economic levels and bio ecology of insect pests. An important component of IPM includes cultural control, mechanical control, physical control, biological control, chemical control and legal control.

Concepts of Integrated Pest Management

- Understanding the Agricultural Ecosystem
- Planning the Agricultural Ecosystem
- Cost/Benefit and Benefit/Risk
- Tolerance of Pest Damage
- Leaving a pest residue
- Timing treatments
- Public understanding and acceptance

Understanding the Agricultural Ecosystem

Ecosystems are self-sufficient habitat where living organisms and the non-living environment interact to exchange energy and matter in a continuous cycle. Agro ecosystem contains a lesser diversity of animal and plant species. A typical agricultural unit may contain only 1-4 major crop species and 6-10 major pest species. The agro ecosystem is intensively manipulated by humans and subject to sudden alteration such as ploughing and treatment with pesticides. Agronomic practices are critical in pest management since the need for pest control or the intensity of a pest problem in often directly related to agronomic practices. Agro ecosystems are more susceptible to pest damage and catastrophic outbreaks because of the lack of diversity in species of plants and species of insects and the sudden alteration imposed by weather and people. However, the agroecosystem is a complex of food chain and food web that interact together to produce a stable unit. Furthermore, the lack of diversity of plant species in agroecosystem is often offset by density; an increased density of plant per acre can dilute pest attack or provide condition

unfavourable to pest increase the plant species that are tolerant or resistant to insects are better able to with stand pest damage or suppress pest establishment and increase.

Planning the Agroecosystem

It is the purposeful manipulation of crop varieties and production techniques to reduce pest problems. In insect pest management, applied agroecosystem planning should anticipate pest problem and ways to avoid them for example a crop variety should not be grown if it is known to be susceptible pest attack, thereby intensifying the need for control activity.

Eg: **Soybean:** *Pubescent type*- resistant to potato leaf hopper, *Empoasca fabae*. Glabrous type – susceptible to potato leaf hopper.

Cotton: *Pubescent type*- resistant to potato leaf hopper, *Amrasca biguttula biguttula*. Glabrous type – susceptible to potato leaf hopper

Cost/Benefit and Benefit/Risk

Farmers are more concern about Cost/benefit. Individual producer of food and fibre are faced with decision concerning pest control while the importance of this decision varies with the crop produce, the method of production, and geographical location of production unit.

Cost /benefit- faced with the possibility of pest damage, the producer is interested in tactics that reduce uncertainty, as long as the amount of expenditure is commensurate with the amount of probable damage by using pesticide. The cost: benefit should be > 1. The cost of production becomes the prediction of pest problem and defining economic threshold will show increased emphasis on cost: benefit.

Benefit/Risk- the social economics of pest control are necessary in developing pest control strategy, particularly when pesticides are used. Benefit/risk analysis provides a means for assessing the relevant economic benefits versus the risk in pesticide control and it is fundamental to pest management. Farmers must consider the hazards of highly toxic insecticides and should take action to ensure the safety for him and workers in handling and application. Besides he must consider the effects on society and environment, otherwise the risks will exceed benefit which becomes ecologically unsound pest control practices. Ex: Application of insecticides might reduce the activity of natural enemies such as predators, parasitoids and pathogens. Use of persistent pesticides leads to residue problems in food stuff and in environment.

Tolerance of Pest Damage

ET is probably the best-known term and most widely used index in making pest management decisions. The ET indicates the number of insects (density or intensity) that should trigger management action. Although expressed in insect numbers, the ET is really a time parameter, with pest numbers used as an index for when to implement management. Just as with EILs, ETs also can be expressed in insect equivalents. The relationships between the EIL and the ET are shown in the figure which demonstrates the action taken when a population level exceeded the ET forced down the population before it could reach the EIL.

Leaving a Pest Residue

An important concept of pest management is the necessity for leaving a permanent pest residue, below the economic threshold, in an area where control measures are conducted. The concept is to suppress a pest. When the population of pests is eliminated from the crop, then the natural enemies of the pest get destroyed due to starvation.

Timing of the Treatments

Crucial problem in successful pest management is the proper timing of insecticide treatment. Treatment should be based on need and a single spray properly timed can often prevent excessive spraying. *E.g.* Use of pheromone traps for activity of adult.

Public Understanding and Acceptance

Educating people about pest management is the most important way to deal with insect pest problem. No programme is any more successful than the degree of commitment made by the people involved.

20276

60. High Altitudinal Effects on Insects and their Responses

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Introduction

Many insect species are broadly distributed along elevation gradients, such that populations living at the upper and lower altitudinal extremes experience quite different environmental conditions, especially with respect to local climate. The comparative study of species ecology along altitudinal transects/gradients may provide clues to the likely response of both species and communities to climate change at any one point over time.

Physical Gradients on Mountains

1. The temperature lapse rate with respect to increasing altitude in the free atmosphere is generally taken to lie between 5.5 and 6.5˚C for each 1000 m ascent.
2. Short-wave radiation within the UV band is known to have deleterious effects on living organisms. The general tendency is for UV radiation input to rise with the increasing altitude.
3. The partial pressure of atmospheric gases including oxygen and carbon dioxide, decreases approximately linearly with increasing altitude.
4. Orographic precipitation in the form of rain or snow often raises significantly along an altitudinal gradient.
5. Wind speed generally increases significantly with increasing altitude. Sustained high winds have important implications for small organisms such as insects that normally undertake routine flight activity-there is a tendency for the populations to be blown away.

Direct Altitudinal effects on Insect Species

Wing size polymorphism and variation

Several studies suggest that insect communities living at high altitudes show a greater incidence of brachypterous or apterous forms compared with the equivalent communities at lower elevation and this associated with the reduced flight activity in harsh cold environments.

Variation in insect size

The mean body size of an insect species may change along an altitudinal gradient. Differences arise from variation in the rates of growth and development at different temperatures and this has important implications for overall reproductive success. For example, Costa Rican butterfly species show similar contrasting trends in wing size with the altitude, with some even reaching maximum wing length at intermediate elevations.

Melanism

The pronounced melanism is the most striking feature of the high altitude's insects. The high-altitude butterflies *Parnassius sps* which are most common on most old high mountains wing markings relatively light coloured at elevations of 2700-3000 m, but almost exclusively and conspicuously darker ones are at higher elevations above 3500 m on the Himalaya.

Thermal tolerance and thermal requirements

The upper and lower altitudinal distribution limits of any insect species will be determined by the capacity of the species to match its thermal tolerance range to the altitudinal temperature profile of its habitat. This is particularly important for long lived cold adapted species such as Grylloblattodea, which rapidly succumb to heat stress at lower elevations.

Response to the declining oxygen

Populations of insect species faced with declining oxygen availability may need to increase their rate of air intake through their tracheal system. This in turn might lead to an increased rate of water loss through the respiratory exchange pathway.

Variation in insect life history and the significance of diapauses

Different species respond to challenges at high

altitudes by a) Reduced number of instars b) Reduced number of generations per annum c) Extending life cycles beyond one-year d) Reduced temperature thresholds for development e) Over wintering of species.

Fecundity

Insects show decreasing fecundity with increasing altitude. This may be due to a) Decreased body size b) Lower food quality c) Shorter time available for oviposition. For example, *Kosciuscola* grasshopper show a pattern decreasing egg production with increasing altitudes. The reduction of eggs due to decreasing in the number of batches laid and reduction in the mean egg size.

Additional genetic considerations

Mountain ranges serve as major barriers for gene flow between same species, potentially producing genetic differentiation between sub populations.

Population density and feeding damage to plants

Several insects show declining densities with increasing altitudes. For example, the patterns of defoliation of mountain birch trees by the moth *Epirrita autumnata* in northern Scandinavia during severe out breaks, extensive areas of forest were defoliated but others remained relatively untouched. Non-defoliated areas were confined to valley bottoms and upland plateaus, with severe damage concentrated at intermediate altitudes.

Parasitism and predation

Searching efficiency and efficacy of parasitoids impaired under cooler even misty conditions at higher elevations.

Community composition and altitude

The number of insect species associated with a particular plant species may decline with rising altitude. Ant tended treehoppers in Colombia exhibit declining species richness with rising altitudes resulting from lower ant densities at high altitudes where as non-tended species do not.

Pollinator's community and pollination

Insect pollinator communities change significantly with altitude and absence of specific pollinators at higher altitudes may restrict successful sexual reproduction in some plant species. A case study in Maxoian county (Schiuan, China) a pollinator decline led to loss in the quality and yield of the apples and forced the farmers to pollinate the apple flowers manually.

References

Hodkinson, I. D. 2005. Terrestrial insects along elevation gradients: species and community responses to altitude. *Biology Reverend*. 80: 489-513.

Spehn, E. M., Maurer, R., Korner, K. C. and Maselli, D. (eds.) 2010. Mountain biodiversity and global change. Gmba-Diversitas, Basel.

20321

61. Different Formulations of Biopesticides

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Introduction

Biopesticides based on microorganisms play an important role in crop protection because of their safety to humans and non-target organisms. These biopesticides have been used by farmers from time immemorial. There are various kinds of biopesticide having different active ingredients, each having specific mode of action and can be formulated in a variety of products. Biological products are highly target-specific, but they are difficult to develop. The reason for this is that, apart from the required good physical properties and convenience in use and the formulated product must have good shelf life. In order to avoid the problems relating to their efficacy and degradation during handling and application different biopesticidal formulations are introduced by various manufacturers.

Biopesticide Formulations

Based on their physical properties, they are classified into liquid and dry formulations

1. **Liquid formulations:** It can be water based, oil based, polymer based or combinations. It requires adding of various inert materials like stickers, stabilizers, surfactants, coloring agents, antifreeze compounds, and additional nutrients.

   Examples of liquid formulations

a) **Suspension concentrates (SC)**: It is a mixture of a finely ground active ingredient dispersed in a liquid medium, usually water. They are produced by a wet grinding process and have a particle size ranging from 1-10 µm. The solid particles are not dissolved in liquid medium, so constant agitation is required before application to evenly distribution of particles.

b) **Oil dispersions (OD)**: Solid active ingredients are dispersed in oil, usually plant oil to improve retention, spreading and penetration properties. It can be used to deliver water sensitive active ingredients.

c) **Suspo-emulsions (SE)**: It is a combination of suspension concentrate and emulsion. The product is very difficult to formulate because it requires to develop both homogenious emulsion component and a particle suspension component to make a stable final formulation.

   i) **Capsule suspensions (CS)**: is a stable suspension of micro-encapsulated active ingredient in an aqueous medium. It should be diluted with water before use. Bio-agent is encapsulated in capsules (coating) manufactured from gelatin, starch, cellulose and different polymers shield it from extreme environmental conditions like temperature, rain, UV radiations etc

d) **Ultra-low volume liquids (UL)**: these are the formulations having very high concentration/ amount of active ingredient which is soluble in crop-compatible liquid (ultra-low volume liquid). There is no need for dilution with water before use and it also consists of surface-active agents and drift control additives. They are easy for use and transport because of low bulkiness.

2. **Dry formulations:** They are produced by various technologies, such as spray drying, freeze drying, or air drying either with or without the use of fluidized bed. These kinds of formulations are manufactured by adding dispersant, binder, wetting agents, etc.

   Examples of dry formulations

a) **Dusts (DP)**: these are formulated by sorption of an active ingredient on finely ground, solid mineral powder like talc, clay, etc with particle size ranging from 50-100 µm. Concentration of ai in dust is about10%. It can be applied either mechanically or manually.

b) **Seed dressing (DS)**: are formulated by mixing an active ingredient, powder carrier and accompanying inert to facilitate product adherence to seed coats. This formulation is applied to seeds by tumbling seeds with the product.

c) **Granules (GR)**: Similar to dust formulations except particle size. Size of coarse particles ranges from 100-1000 microns and micron particles ranges from 100-600 microns. Concentration of active ingredient in granules ranges from 5-20%.

d) **Wettable powders (WP)**: These are dry, finely ground formulations to be applied after adding water. These are manufactured by combining active ingredient with surfactant, wetting and dispersing agents and inert fillers, followed by powdering to a particle size of nearly 5 microns.

e) **Water dispersible granules (WG)**: Water dispersible granules are suspended in water to form uniform suspension similar to that formed by a wettable powder. The products is a mix of wetting agent and a dispersing agent, but the dispersing agent is added at higher concentration. Water dispersible granules can be formulated using various techniques like extrusion granulation, spray drying, fluid bed granulation etc.

Conclusion

Biopesticide formulations are very convenient for the users as it allows the use the same equipment for different treatments. The viability of these bioagents should be maintained at appropriate levels during the formulation process and storage. At the time of application, the organisms must revive from their inactive state to an active stage. Formulating biopesticide products requires fundamental understanding of the processes causing the loss of viability. The formulation process should lead to a final product by mixing the microbial component with different carriers and adjuvants for better protection from environmental conditions, greater survival of the biological agent, controlled rates, as well as improved bioactivity and storage stability.

References

[1] Gašić S. and Tanović B., (2013) Biopesticide Formulations, Possibility of Application and Future Trends. *Journal pesticides and phytomedicines*.28(2):97-102.

[2] Lyn M.E., Burnett D., Garcia A.R. and Gray R., (2010). Interaction of Water with Three Granular Biopesticide Formulations. *Journal of Agricultural and Food Chemistry*. 58(1):1804-

1814.
[3] Winder R.S., Wheeler J.J., Conder N., Otvos S.S., Nevill R. and Duan, L. (2003). Microencapsulation: a Strategy for Formulation of Inoculum. *Biocontrol Science and Technology*.13(2): 155-169

20336

62. Parthenogenesis in Insects

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Parthenogenesis is a form of asexual reproduction where offsprings are produced without fertilization. Although parthenogenesis is less common than sexual reproduction, it is still prevalent in many insect species. The most well-known example is the Indian stick insect (*Carausius morosus*). Parthenogenesis is of two types:

1. *Occasional parthenogenesis:* It occurs due to the failure of a female to find a mate.
2. *Obligately parthenogenesis:* It is seen in almost all of the insect orders except Odonata, Neuroptera, Dermaptera and Siphonoptera.

Forms of Parthenogenesis

Thelytoky

In thelytoky all unfertilized eggs develop into females to produce diploid offspring. Thelytokous species are generally found in orders Thysanoptera, Psocoptera, Hemiptera and Phasmatodea.

Mechanisms of thelytoky

There are mainly two mechanisms; (a) apomixis, in which there is no meiosis of the egg and the resulting female offspring are genetically identical to their mother. (b) Automixis, in which meiosis occurs but diploidy is restored by duplicating the genome of the egg before meiosis, creating a 4n cell. This is seen in some Orthoptera and Coleoptera.

Thelytoky in grasshoppers (Orthoptera) and stick insects (Phasmatodea) is associated with interspecific hybridization, resulting from the mixing of foreign chromosomes. In other insects, thelytoky has evolved in the absence of hybridization and influenced by several genetic loci *e.g.*, Drosophila. Maternally transmitted bacteria in the genera *Wolbachia* are also well known to induce thelytoky in the parasitoid wasp, *Trichogramma cacoeciae*.

Arrhenotoky

In arrhenotoky unfertilized haploid eggs develop into males and fertilized (diploid) eggs develop into females. It is also known as haplodiploidy, present in nearly all species of Hymenoptera and Thysanoptera along with some taxa of Hemiptera (scale insects and whiteflies) and Coleoptera. In arrhenotokous, the mother (Hymenoptera) can control the sex ratio of her offspring by deciding whether or not to fertilize the egg by controlling the release of sperm from the spermatheca.

Mechanisms of arrhenotoky

Complementary sex determination (CSD) is a mechanism for arrhenotoky in the majority of Hymenopterans. One explanation is single locus-CSD with multiple alleles where heterozygous individuals at this locus develop into females and hemizygous individuals develop into males (FIG. 1). Whereas in chalcidoids, multi-locus CSD is a possible explanation for their sex determination.

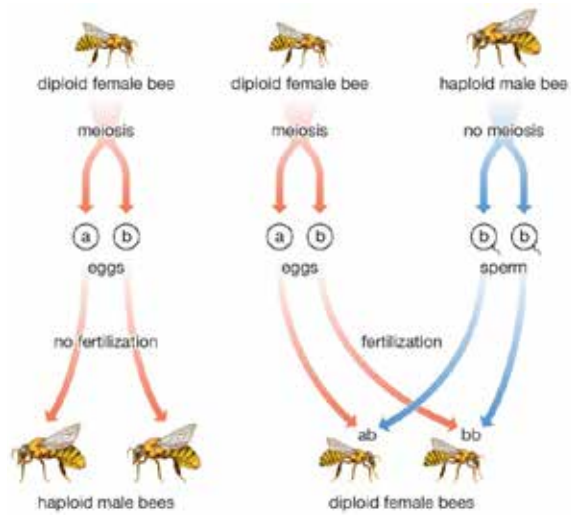

FIG. 1: Haplodiploidy in bees. Source: *Encyclopedia Britannica, Inc.*

Hermaphrodism

Hermaphrodism is a rare form of arrhenotoky related development in insects, where the progeny develops from self-fertilization of eggs and sperm produced by the same individual *e.g.* few scale

species (Icerya). In *Icerya purchasi*, the population consists entirely of hermaphrodites, apart from a few haploid males with no true females.

Alternation of generations

Some insects undergo reproduction that includes alternate series of asexual (parthenogenesis) and sexual reproduction through alternation of generations. This is most common in Hymenoptera and Hemiptera. It also occurs in gall wasps depicting alternate parthenogenetic and arrhenotokous generations. Aphids exhibit a more complex alternation of generations, with several parthenogenetic generations during summer and sexual offsprings in winters.

20350

63. Blood Sucking Mechanism in Order Diptera

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Introduction

A part from heterogeneity of mouthparts of Diptera, in most primitive groups, that belong to lower Diptera (Nematocera and Orthorrhapha), the mouthparts are composed of three median and unpaired appendages and two pairs of symmetrical appendages. The first ones, from cranial to ventral, are represented by the epipharynx, the hypopharynx and the labium; the paired appendages are the mandibles and the maxillae. In several groups of lower Diptera, the mandibles and part of maxillae are strongly reduced, vestigial or loss. The shape of epipharynx, mandibles, maxillae, and hypopharynx is usually narrow and less or more elongated. In piercing mouthparts they are called also stylets. The labium is more developed and concave in the dorsal side, so it can allow the stylets. Due its form, the labium is usually called proboscis.

Blood Sucking Insects in Diptera

- 226 species of mosquitoes (Culicidae)
- Biting midges (Ceratopogonidae)
- Black flies (Simuliidae)
- Horseflies (Tabanidae)
- Culicidae include 41 species from 10 subgenera of 5 genera of 2 subfamilies
- Simuliidae are represented by 110 species of 23 genera, belonging to 6 tribes of 2 subfamilies
- Culicoides of the Ceratopogonidae, by 31 species
- Tabanidae, by 44 species of 7 genera from 2 subfamilies
- The best known of the mandibulate piercing flies are the female horse flies (Tabanidae), and female mosquitoes.
- Flies having a piercing labium including tsetse fly, stable fly, and horn fly of the family Muscidae.

Organs Associated in Sucking the Blood

Labrum attached to the lower margin of the facial area of the head by a median membranous area and two divergent lateral arms. A short median apodeme projects dorsally into the head cavity from the anterior wall of the labrum and gives insertion to a fan-shaped muscle arising on the clypeal plate of the head (Tabanidae). This muscle serves apparently to keep the labrum in close contact with the other pieces of the mouth parts. The presence of a clypeolabral muscle is a special feature of the Diptera and constitutes an exception to the general rule that the labral muscles take their origin on the frons.

Sucking Pump

The sucking apparatus is a small chamber which extends upward in the lower part of the head from the functional mouth. The posterior and wide lateral walls of the organ are strongly sclerotized and fixed to the upper end of the labrum. The anterior wall, on the other hand, is thin and flexible and is ordinarily deeply invaginated into the lumen of the pump, but it is provided with two large groups of muscle fibers taking their origin on the median clypeal plate of the head wall and is thus capable of exerting a sucking action on the liquid food ascending to the mouth through the food canal of the mouth parts. Dilator muscle of the pump on the median plate of the clypeus. The functional mouth aperture leading into the pump chamber, therefore, is not the true mouth, the latter being the opening into the stomodaeum at the inner end of the pump.

Blood Sucking Mechanism

Labrum and epipharynx

The labrum is a region derived from preoral somites, but in Diptera it takes part of mouthparts.

In bloodsucking or predaceous Diptera, usually, the epipharynx does not take part to piercing function, except the Culicidae, where this appendage is well elongated and is inserted into the bite with the other stylets.

Mandibles

The presence of the mandibles is functionally significant only in bloodsucking or predaceous females, where they become piercing organs. In Culicidae, the mandibles are long and slender and have the medial margin finely serrated; instead, in bloodsucking and insectivorous females of other groups, the mandibles appears as short blades. In males of these species, the mandibles may be present but are reduced or otherwise they are not functional. In Tabanoidea, when present, the mandibles close the ventral part of the food canal, by approaching to the epipharyx.

Maxillae

Females of Culicidae have long maxillary stylets, shaped as serrated blade in the distal, while in other groups they appear as short blades.

Hypopharynx

In bloodsucking Diptera, the saliva contains anticoagulants (Anticoagulin) and other substances that aim to reduce the time of suction or delay the reaction of the host. For example, Rubefacient substances, which causes the dilation of capillaries and speed up the blood flow, and anesthetic substances.

Labium

- **Basiproboscis or rostrum**: It is the proximal portion, shaped as a truncate cone, often retractile.
- **Medioproboscis or hautellum or theca**: It is the middle portion, forming a groove in the dorsal side and a sclerotized area in the ventral, identified as the prementum.
- **Distiproboscis:** This is a bilobed expansion of the proboscis, derived from the modification of labial palpi. The two lobes, generally fleshy and elastic, are called labella.

References

Hennig, W. (1973) Imagines: 141-236. In Diptera (Zweiflüger).

Snodgrass, R.E. (1935) Principles of insect morphology.

INTEGRATED INSECT PEST MANAGEMENT

20237

64. Integrated Management of Desert Locust

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Introduction

Locusts are the short horned grass hoppers belongs to the family Acrididae they are diverse from grass hoppers in terms of changing behavior, high migratory habit. Locusts are mentioned in epic poem `Mahabharatha". All the grass hoppers can be locusts but all the locusts cannot be grass hoppers. Locusts are the voracious feeders with marked polymorphism and considered as most destructive, notorious, polyphagous pests. They possess serious threat to food security by enormous swarms that spread across the regions devouring crops and leaving serious damage to nature and agriculture. They are torture to mankind since many decades. They are considered as most harmful insects in the world. Sleeping giants that can wake up leading to national food and fodder emergencies.10 important species of locusts are found in the world of them only 4 species are found in India. They are: 1) *Schristocera gregeria* – Desert locust, 2) *Locusta migratoria* - Migratory locust 3) *Anacridium* sps - Tree locust 4) *Patanaga succinta* - Bombay locuct. In the year 2016 Tree locust upsurge has been occurred in India and in 2017 same tree locust upsurge were reported as per L.W.O. reports. In the year 2019 total 1500 swarm incursions of Desert locust was reported in the states of Rajasthan and Gujarat and about 3,14,645 litres of malathion was used in control. In India monitoring, survey and controlled of desert locust in scheduled desert areas (SDA) is monitored by locust warning organization (L.W.O.) which is now merged in directorate of plant protection quarantine and storage.

All About Desert Locust

Desert locust is considered as International Transboundary insect pest. Historically desert locust being always a threat to man's wellbeing.

The desert locust is mentioned as curse to mankind in ancient writings like Holy bible and khuran. The damage and loss caused by desert locust is beyond imagination as they cause starvation an average locust swarm eats one day as 10 elephants, 25 camels or 3,500 people. It causes damage by devouring leaves, flowers, fruits, seeds, bark and growing trees. Schedule Desert areas are breeding grounds for locusts. Desert locust has 2-5 generations in a year. Locust outbreaks generally triggered by rains in desert areas after a dry spell. It prefers sandy soil for egg laying. Life cycle consists of 3 phases namely egg, hopper and adults. Egg period lasts for 10-65 days, Hoppers contain 5 instars and lasts up to 24-95 day. Locusts have 3 breeding seasons (i) Winter breeding season (November to December) (ii) spring (January to June) (iii) Summer (July to October) India has only one breeding season and neighboring Pakistan has both spring and summer breeding seasons. Two phases of locusts are found they are solitary and gregarious. Solitary do not form groups or swarms and moves as individuals' adults having greyish brown colour. Gregarious very mobile and fly as swarms per day. Gregarious adults are distinguished by having rosy pink fledging's. At field the locusts are scattered, living singly production of serotonin enhances its transmission to gregarious phase, and other reason includes production of Guaiacol in the gut of desert locust by the breakdown of plant material. Guaiacol is the main component of pheromone that enhances locust to swarm. Multiplication of locusts is done after the rains and this leads to grangerization.

Integrated Desert Locust Management Strategies

Locust invasions are difficult to control as they breed in remote areas and migrate over long distance in swarms. Economic Threshold level (ETL) is 10.000 adults/ ha and 5-6 hoppers/bush. 1adult/ square meter is enough to cause loss. The primary method of locust control is through application of chemical pesticides. Locusts cannot be controlled by single method as they are gregarious. On receiving the message of locust swarm invasion following preventive measures should be implemented:

1. Farmers should go to their cropped field and make loud sound by beating empty cans/ metal plates, drum or radio or through other electronic system or through fire crackers which make loud noise.
2. Dig a trench 2 feet deep and wide in front of marching hopper band and then pour water in the trench mixed with kerosene oil
3. Use of flame throwers against the swarms. It is recommended when there is no cropping.
4. If a hopper band is formed and observed marching ignite dry grasses or any trash in front of the marching hopper band to kill the nymphs.

Locust management through flame throwers.

Making loud sounds by beating metal plate.

5. If the hatching of eggs started and nymphs observed, spray bio pesticides like metarhizium anisopliae var. acridium @75 gm/15 litres of water or dust any insecticide like quniolphos 1.5 % DP or chloropyrophos 1.5% Dp or methyl parathion 2% DP @25 kg/ha to kill emerging nymphs.
6. Spray anti-feedents like neem based formulations (0.15% EC)@45 ml/15 liter of water.
7. If oviposition holes are found in the uncultivated fields, first dust any insecticide (Chloropyrophos 1.5% DP or methyl parathion 2%DP @25 kg/ha) plough the field to kill the eggs and emerging nymphs.
8. Various predators like meloid beetles and larva bombylid flies are effective against the egg's pods of locusts.
9. Use of entomopathogenic nematodes like stenernima carpocapse is very effective as it showed 100% mortality on desert locusts.
10. Dust the crops with Qunolphos @25 kg/ha on

standing crop.

11. Use of diflubenzuron 25% WP is effective against the hopper stage only.
12. If Hopper band is roosting either go for dusting spray, malathion 96% ULV @1.0 lit/ha or with fenitrothion 96% ULV@ 1.0 lit/ha.
13. If it is on large cultivated land, apply same dust of ULV formulations using vehicle mounted dusters/ ULV sprayers as the case may be.
14. If it on large uncultivated land, apply same dust of ULV formulations using vehicle mounted dusters/ ULV sprayers as the case may be.
15. If the locust swarm is spotted invading a cropped area the state agriculture department should arrange Aerial spraying of ULV formulations through air crafts insecticide like malathion can be used @ 1.0 lit/ha.

SERICULTURE

20363

65. Sericulture in Assam and Farmer Producer Company

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Sericulture is deeply rooted in culture and tradition of Assam. In Assam sericulture is practised from time immemorial. Francis Hamilton remarks that Assamese women of all castes from the queen downwards wove four kinds of silk that are produced in the country, and with which three fourth of people were clothed. Kautilya mentioned the production of Dukula a kind of silk fabric, produced from cocoons of certain species of insect in the ancient Assam (Phukan, 2012). Sericulture has been playing a major role in socio-economic development of Assamese people. Despite having congenial natural habitat for sericigenous insect and a rich history of their cultivation Assam's sericulture production and productivity is very low as compared to other silk producing regions.

In the current globalized economy, Assam sericulture sector can play a pivotal role in rural development and employment generation. Assam is a place with congenial eco-climate and geographical condition which is suitable for culture of all four commercial silkworms *viz*., muga, eri, tasar and mulberry (Gogoi and Goswami, 2016). It is notable to emphasize that Assam is not only homeland of al l domesticated silkworm races and their wild counterparts but also homeland of their various host plants. The culture and production of golden shimmering silk is prerogative to North-Eastern region of India - the world famous muga silk, which can increase export earning of Assam tremendously. Moreover, various other wild silkworm races are also obtainable in Asaam. This has made Assam the most latent state for sericultural development in the world. Once Mahatma Gandhi termed Assamese women as the "Weaving Wizard, which Weaves Dreams." Assamese women are experts in traditional weaving technique; this rich heritage can be used to promote traditional cottage industry.

1. Muga silk yarn 2. Eri silk yarn 3. Mulberry silk yarn 4. Tasar silk yarn

The major bottle necks to Assam's silk industry are lack of scientific production practice, Small and scattered production, lack of sufficient systematic host plants and presence of exploitative market for Seri-farmers. These bottlenecks can be overcome by encouraging farmer Producer Company among Seri-farmers. With collective production in FPC farmers can benefit by procuring input in bulk.

Weaving of muga silk (Photo source Google images)

With the help of government and non - government bodies farmers will be able to apply scientific production practices in their field. By collective marketing through farmer Producer Company farmers will gain bargaining power in market. Establishment of silk spinning and weaving plants in local area will be possible by small farmers with the help of FPC. In numerous ways farmer producer company can benefit the rural economy. As in case of " Dev Bhumi natural products producers co. ltd" which is working towards its vision of creation and conservation of through enterprise in core activities like sericulture, organic honey, organic spices and eco – tourism in remote villages of Uttarakhand (Krishi sutra-2, 2013). Such successful developmental models can also be applied in rural areas of Assam for rural development.

References

Phukan R. Muga Silk Industry of Assam in Historical Perspective. *Global Journal of Human Social Science History and Anthropology*. 2012; 12(9):4-8

Gogoi B, Goswami BC. Silkworm Bio-Diversity of Assam: its Exploration and Development. *International Journal of Interdisciplinary Research in Science Society and Culture*. 2016; 2(1):400-407

Krishi sutra 2. Success stories of farmer producer Organizations. A producer's company owned by Rural women in Uttarakhand. 2013; 2:23-24

SEED SCIENCE AND TECHNOLOGY

20193

66. Lea Protein: Its Role in Desiccation Tolerance of Seed

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A living cell undergoes greater physical and chemical effects on cellular and macromolecular structures due to dehydration which usually causes irreparable changes and ultimately lead to cellular death. The phenomenon of moisture loss is known as desiccation. Thus all biological systems are susceptible to moisture loss and in most of the cases lead to death, but seed is able to withstand loss of moisture *viz.*, desiccation tolerance. Hence, seed's desiccation tolerance ranges from 80% moisture during embryo formation and then it is reduced to mere 15-20% during maturation.

Late Embryogenesis Abundant (LEA) Protein

LEA's consist of a set of hydrophilic and heat-resistant proteins which are related with acquisition of desiccation tolerance mechanism during seed maturation. The function of LEA protein acts as a protectant, perhaps stabilizes subcellular structures during desiccated condition. LEA's synthesis which appears to be correlated with high ABA levels that become peak during later stages of seed development.

Seed Development and LEA Protein

Embryogenesis means the embryo formation that represents the series of formation stages to form a miniature plant in flowering plants within the seed. The initial stage is fertilization, the zygote develops and then leads to the viable embryo formation and then undergoes subsequent development. Next stage of cellular expansion is identified by an increase in dry matter production and provides energy for the germination process. Final seed development stage *viz.*, maturation which initially undergoes natural reduction in seed water content eventually drops to ~10% in most plants. At this stage, the expression of gene and protein profiles greatly changes and usually associated in achieving desiccation tolerance such as increasing abscisic acid (ABA) content, developing seed germination capacity, accumulation of Late Embryogenesis Abundant (LEA) proteins and moreover, mRNAs of LEA proteins in the dehydrated mature embryo are maintained at a high level.

Physiological Roles of LEA Proteins

Desiccation-sensitive seeds get desiccation tolerance after the synthesis of de novo LEA proteins due to precocious maturation. Hence, considering their redundancy and high amounts, LEA proteins are suggested as one of the key factors for acquisition of desiccation tolerance. But LEA proteins would disappear during seed germination but their constituent amino acid residues might be utilized during seed storage. So, LEA proteins play an atypical storage role during germination of seed.

Orthodox Seeds

Orthodox seeds withstand dehydration upto ~5% of water content even when maturation drying is not completed prior to shedding. During desiccation intra-water molecules loss causes dehydration that induce LEA proteins to refold and get interacted with oligosaccharides to form bioglass. Intracellular bioglasses recommended to play an important role in desiccation tolerance and seed storage stability. However, simple sugar mixtures or glasses do not tolerate desiccation unless other components of bioglass, like LEA proteins involved in glasses. During desiccation, LEA proteins interact directly with proteins, oligosaccharides and plasma membranes and then it may enhance bioglass strength as well as act as a water replacement for stabilizing cellular components.

Recalcitrant Seeds

Recalcitrant seeds having little or no maturation dehydration and will always remain desiccation sensitive during its development. Such seeds are shad hydrated at the minimum water content to be at ~23% on a wet mass basis. Generally, the range of seed moisture content is 30 to 80 percent. Most of the recalcitrant seeds cannot survive under dehydration or chilling (<10°C) so they are not able to store for long periods.

LEA proteins and oligosaccharides may accumulate in some recalcitrant seeds, and bioglasses form during its dehydration. The glass formation occurred only at the water content <10-15%, whereas such water content of recalcitrant seeds was well below its lethal limit. However, before these protection mechanisms operate in recalcitrant seeds, slowly dried seeds have already lost its viability.

Conclusion

So, for membranes are potentially very important targets for LEA proteins which act as soluble cell compartments. Specific LEA proteins are expected to be targeted at membranes that contribute to their protection and maintain their integrity of cellular membranes during acute stress viz., desiccation or maybe freezing.

20218

67. Importance of Packaging in Maintaining the Seed Quality during Storage

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Introduction

Seed is basic input or foundation for enhancing crop production. Since seeds serve as main genetic linkage between two generations of a plant species, so they must be stored in good storage conditions. Good storage conditions are required to preserve the germination capacity, viability and vigour of seed. As seed is hygroscopic in nature, it is bound to deteriorate fast in storage due to fluctuations in ambient storage conditions. This deterioration can be checked effectively by storing seeds in suitable storage containers.

Basically, seed storage is the preservation of seed in its initial quality until next planting. In temperate regions, seeds can be stored at ambient conditions for longer period, whereas in tropical and sub-tropical regions parameters such as temperature and moisture should be adjusted as per the requirement to preserve the seed vigour.

Factors affecting the Quality of Seed During Storage

The viability and vigour of the seeds vary from genera to genera and variety to variety in storage. It is also significantly affected by many physicochemical factors like initial seed quality, composition of seed, moisture content, atmospheric relative humidity, temperature, gaseous exchange, storage structure and packaging materials etc. To overcome the effect of these factors and to extend the shelf life of seeds in storage, it is prerequisite to store the seeds in suitable storage containers.

Why Packaging is Necessary

Packaging provides the proper covering material for seed in transport or storage to ensure against loss of seed and to ensure survival of seed. So, packaging plays a vital role for the protection and durability of the seed. Seeds can be packed in suitable storage containers to maintain their viability and vigour for longer time. Different types of seed storage containers also influence the seed storability at different storage environment. Under ambient conditions, seed storability is better in moisture impervious containers like aluminium foil and polythene bag as compared to moisture pervious like cloth bag and paper bag with low seed moisture.

Moisture content of the seed is the most important factor influencing viability of the seeds during storage. Being hygroscopic in nature, seed tends to absorb moisture from its surroundings. Increased moisture content of the seed harbours frequent growth of molds and seeds are vulnerable to attack by pests. Seeds with more than 14% of moisture content deteriorate quickly, whereas very low moisture content is also harmful to seed quality. Therefore, it is very essential to store the seed in impervious containers to slowdown the deterioration process of seed in storage.

Selection of Packaging Material

Seed packaging consists of three basic steps which are filling, weighing and sewing of bags with seeds. Before we go for selection of packaging material there are various factors which are to be considered. These include kind of seeds to be packed, quantity of seed, value of seed, cost incurred in packaging, storage environment in which the packed materials will be placed, duration of storage and transport of seed.

It is very necessary to package seed in dry containers for proper storage. Tin cans, jars, or pots that are glazed on the inside can be suitable containers for storing small quantities of seed along with reinforced boxes or bags. For packaging large quantities of seed metal or plastic cans, gunny bags or drums are suitable. In spite of the type of container used, it should be of standard size and shape so that when one is filled with seed of a known purity percentage, the approximate number of seeds it contains can be estimated. Proper packaging makes handling process also easier with the containers of standard size and shape. For subsequent identification, each package of seed, or each cluster of packages representing a given seed collection should be labeled properly.

Time of Packaging Seeds

The best time of packaging seeds is just after the

moisture content of seed has been determined and found to be within the safer limits of storage. Equilibrium is always found between moisture content of seed and the relative humidity of the environment. Therefore, if possible, seeds should be packaged into containers and after that hermetically sealed in the drying room.

Types of Containers used in Packaging

Seeds packaging can be done in various types of containers depending upon the suitability of containers to different environments. For example, if seed store has facilities for regulating temperature and relative humidity, then moisture pervious containers can be effectively used for orthodox seeds for many years, provided that pests can be excluded *e.g.* cotton bags, paper cardboard and fibre board.

Moisture impervious containers can be used after drying the orthodox seeds to required moisture content. Dehumidification requirements can also be avoided by sealing the containers. Seeds can be stored for long time when moisture proof containers are combined with controlled low temperatures provided by refrigeration. This method provides an added advantage of exclusion of oxygen. However, this method is not suitable for recalcitrant seeds *e.g.* 700-gauge polythene bags.

Moisture resistant containers such as polyethylene or other plastic films and aluminum foil are resistant to the passage of moisture but over a long period of storage, slow passage of water vapour will take place tending to equilibrate the relative humidity inside and outside the container.

Conclusion

Proper packaging serves as an essential tool for good storage stability of food grains and seeds. It is not only excellent barrier to moisture, air and odors but also inhibits the growth of microorganisms. Handling and identification of product becomes much easier and quality can be maintained for longer period of time with the proper packaging.

20295

68. Role of Karrikins on Seed Germination

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Seed release and germination will be spontaneously at seed maturation in many plants triggered by environment lately or at that stage of seed maturation is an ecological adaptation. The most common and best studied environmental trigger is wild fires or bush fires which leads to smoke was known to stimulate seed germination. The chemicals present in smoke of fire are responsible for such phenomena and one such chemical compound is karrikin. Karrikins are a group of plant growth regulators representing butenolide class that are released from the smoke when plants are burnt. Various chemical compounds are detected from the smoke of burnt plant materials, notably a series of butenolides, these are responsible for the stimulatory effect on seed germination (Flematti *et al.*, 2004; Staden *et al.*, 2004). Karrikins therefore are defined as a class of butenolide compounds isolated from smoke with known ability to break seed dormancy or stimulate germination and also promote seedling vigour. The "karrikins" are named after the local indigenous word "*karrik*" which means smoke. Currently, there are six known karrikins which are designated as KAR1, KAR2, KAR3, KAR4, KAR5 and KAR6 but KAR1, KAR2 are most active. They are formed from carbohydrates (sugars and cellulose) by heating or combustion. The basic structure of karrikins consists of a five-carbon lactone ring and a six carbon pyran ring. The first discovered KAR1 is chemically known as 3-methyl-2H-furo [2, 3-c] pyran-2-one, also known as Karrikinolide. These compounds can trigger the seed germination and control seedling growth at parts per billion (ppb) concentration (Flematti *et al.*, 2004).

The effect of KAR on germination parameters of many field and vegetable crops is reported positively (Table) and quickly can overcome primary dormancy. Effective on hypocotyl elongation and germination stimulation under continuous red light condition (similar like auxins) due to positive influence on chlorophyll a and b. The compounds of KARs may stimulate either cell elongation and division. They interact with endogenous phytohormone signaling by regulating the ABA and GA levels. KARs can increase the efficiency of an embryo's oxygen absorption, water uptake and starch break down (increases alpha amylase activity). KARs also have shown increased seed masses and highly seedling vigour, tells it has roe in post germination stage. The compounds like butelonide (KARs) which one is stable, water

soluble and active at low concentration is ideal for preconditioning or seed priming agent. Seeds during imbibition leads to soaking injury due to prolonged time and wide range of low and high temperatures, which are detrimental and affects its metabolism (lower temperature) and protein conformational changes (high temperature). In sub and supra optimal temperatures also, the seeds have grown better which is enabled by KARs priming treatment.

Sl. No	Conc. [M]	Crop	Growing condition	Examined Features	Effects of KAR	
					Increase	Decrease
	Field crops					
	10^{-10}	Rice (*Oryza sativa* L.)	Petri dish	SW, RL, SL	SW, SVI, RL, SL	
	10^{-7}	Maize (*Zea mays* L.)	Pre-soaked in KAR_1 solution for 1 h	SW	SW	
	Vegetables					
	10^{-7}	Tomato (*Lycopersicon esculentum)*	Petridish	% of AS, SVI, SW	SW	% AS
	10^{-7}	Tomato (*Lycopersicon esculentum*)	seeds were primed in KAR1 solution for 24 h	SVI	SVI	
	10^{-6}	Amaranth (*Amaranthus hybridus* L.)	grown in pots drenched by KAR1 solution once a week or foliar application	SL, SDW	SL, SDW	RDW
	10^{-7}	Carrot (*Daucus carota* L.)	Pre-soaked in KAR_1 solution for 12 h	GER, RDW	GER, RDW	
	10^{-7}	Okra (*Abelmoschus esculentus)*	grown in Petri dishes with KAR_1	SW, RDW	SW, RDW	
	10^{-7}	Pepper (*Capsicum annuum* L.),	grown in pots irrigated by KAR_1	SE, SDW, MET, CA	SE, SDW, CA	MET
	10^{-7}	Pepper (*Capsicum annuum* L.)	Pre-soaked in KAR1 solution for 40 h	GER, SE, SDW, CA, SOD	GER, SE, SDW, SOD	CA

Seedling weight (SW), Seedling vigor index (SVI), Abnormal seedlings (AS), Root Dry Weight (RDW), Seedling Emergence (SE), mean emergence time (MET), catalase activity (CA), superoxide dismutase activity (SOD), shoot length (SL), root length (RL)

Mavi *et al*. (2010) examined the effect of hydro priming and butenolide priming (10^{-7}M) treatment on seedling emergence and growth at different sowing depths (4 and 8 cm) at 20 in melon seed lots of high (Lot 1) and low (Lot 2) quality. At 20 temperature butenolide primed seeds of both lots emerged earlier. Butenolide primed seeds of lot 2 at eight centimetre depth and at 20 temperature reached 83 per cent germination while hydroprimed seeds had 42 per cent germination after eight days.

Muhammad Iqbal *et al*. (2016) studied the effect of plant derived smoke on germination and post germination expression of wheat seeds. Non-imbibed and imbibed seeds of wheat were exposed to plant derived smoke for 1 h time duration. Best results were observed in non-imbibed seeds treated with plant derived smoke while, imbibed seeds showed poor response to germination percentage, germination index, seedling vigour index and root shoot length.

Conclusion: The new characterized compounds KARs (butenolide) has multi-disciplinary role in enhancing seedling growth in many plant species. Isolation and identification of karrikins provides an important opportunity for extending the benefits of smoke technology in horticulture, agriculture and conservation science. The effect of karrikins in the crops that were studied is quite positive particularly on seed germination and seedling vigour hence the utilization of these karrikins needs to be exploited in seed science research particularly for seed quality enhancement.

References

Flematti, G. R., Ghisalberti, E. L., Dixon, K. W. and Trengove, R. D., 2004, A compound from smoke that promotes seed germination. *Sci.,* **25**:305: 977.

Mavi, K., Light, M. E., Demir, I., Staden, V. J. and Yasar, F., 2010, Positive effect of smoke derived butenolide on melon seedling emergence and

growth. *New Zealand J. Crop and Hort. Sci.*, **38**:147-155.

Staden, V. J., Sparg, S. G., Kulkarni, M. G. and Light, M. E., 2006, Post germination effects of the smoke derived compound 3-methyl-2H-furo[2,3-c]pyran-2-one, and its potential as a preconditioning agent. *Field Crop Res.*, **98**: 98-105.

Muhammad Iqbal, M., Asif, S., Ilyas, N., Raja, N.I., Hussain, M., Shabir, S., Faz, M.N.A. and Rauf (2016) Effect of plant derived smoke on germination and post germination expression of wheat (*Triticum aestivum* L.). *Am. J. Pl. Sci.*, **7**: 806-813.

EXTENSION EDUCATION AND RURAL DEVELOPMENT

20240

69. Impact of Covid-19 Containment on Indian Agriculture: A View

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A disease spread very fastly throughout the world from Wuhan, China, now well known as epicenter of the disease named COVID-19. It's a very infectious disease caused by corona virus: type-SARS co v2 which engulfed 187 countries and announced by the World Health Organization as "A PANDEMIC". Now it is a bitter truth of whole world, which they have to tackle with. Till now a date there is no proper medicine/ vaccine or any treatment, which shows- how far the technology has developed but we are incapable of combating such calamity. This disease has affected 6,714,335 people with 3, 03, 339 deaths worldwide, many have recovered also *i.e.* 1,703,637 patients till the date. The recovery rate is good but the spreading rate is very high so, to contain this disease major steps were taken by the countries and the only way was lockdown. India has taken early action to limit the spread, ordering 1st 21-day nationwide lockdown, putting 1.3 billion people under confinement starting from March 25, then 16-day lockdown extension to 3rd may with some relaxation and again 17 days lockdown till 17th of May with releasing lockdown in green zones. The current cases in India are 81, 997 and death 2,649 with recovery 27, 969. However, cases are increasing per day and lockdown continues in different zones.

Problem Faced by Farmers during Lockdown and how Govt. is Trying to Contain Covid-19

In this challenging time how the Indian agriculture responded to crisis and what challenges COVID -19 has posed to the farm sector? There was too much panic in economically backward mainly the daily wagers and those coming under below poverty line because their livelihood fully depends upon their day to day activities and there was too much uncertainty about the functioning of the system. Restricting movements of people and vehicular traffic has resulted in negative implications on the farm economy and created chaos among the farmers. This time is peak for Rabi season in India and crops like wheat, gram, lentil, mustard, etc. (including paddy in irrigated tracts) are at harvestable stage or almost reaching maturity. This is also the time when the farm harvests reach the mandis. So, immediately after the nation-wide lockdown was announced, the Indian Finance Minister declared an **INR 1.7 trillion** package, mostly to protect the vulnerable sections (including farmers) from any adverse impacts of the Corona pandemic. The pronouncement, among a slew of benefits, contained advance release of -

INR **2000** to bank accounts of farmers as income support under PM-KISAN scheme. **The Indian Council of Agricultural Research (ICAR)** has issued state-wise guidelines for farmers to be followed during the lockdown period. The advisory speaks briefly on specific practices during harvest and threshing of various Rabi (winter sown) crops as well as post-harvest, storage and marketing of the farm produce.

Cash crops have suffered the most, in Tamil Nadu and Maharashtra farmers who grow crops like cotton, onion and bananas transportation proves to be a big issue. A farmer in Bangalore was distressed enough to feed his strawberries to cows in rural areas. Whereas, in cities the supply was low with increasing demand from urban and as well as middle class consumers, may create

irreparable damage and huge crop waste. It has triggered emergency in both harvesting operations and post-harvest handling of produce in storage and marketing centres. Farmers are being forced to discard unexampled or novel amounts of food surplus because of the closure of schools, restaurants, and hotels and because of the diverting food supply away from wholesalers directly into the hands of consumers can be costly. Govt. come forward to combat the situation and notified to exclude movement of farmers, farm labourers and harvesting and sowing-related machines from the purview of lockdown. Making the food grains, fruits, vegetables and other essential items available to consumers.

Figure 1 A hungry lady picking some vegetables from garbage, thrown during lockdown for her family.

Figure 2 A milk man pouring extra milk in river The sale of dairy products; fish; poultry, etc. has also been hit badly during the lockdown period. A steep decline in consumption could be seen due to slow demand and supply. Initially, many people didn't buy chicken because of rumors calming that COVID-19 might spread through poultry. After the hawk ministry write letter on 23rd march to chief secretaries of all states to issue necessary direction to include poultry in list of essential commodities. Another letter for the poultry fodder availability was written to allow movement of animal feeds. Another problem was the milk consumption, as, all sweet shops and factories were closed small farmers were forced to throw milk in rivers. However, the ministry is unable to estimate total milk loss.

VILLAGERS WORK UNDER MGNREGA SCHEMES

EEFORTS OF MGNREGA - AAGE BADHE CHALO

Very comforting news that came amidst all the chaos caused by this pandemic is that the mother

earth is detoxifying herself. Due to the sudden lockdown in different countries whole world stopped at some point, factories closed, vehicles stopped, Mining stopped, electricity Consumption declined and due to this sudden pause leads to very effective decrease in pollutants and global gasses (NO_2 and CO_2) which on other hand limited the water holding capacity of atmosphere. As a result, weather has been very erratic over past few months in many parts, so, it has become a challenge for the farmers to protect their harvest from such risks. But we all know agriculture never stops these farmers are serving humanity now and then every day in adverse calamity.

Conclusion

The strategy of containing the infection through early and sudden lockdown has proven scourge to farmers and economically backward mainly the daily wagers and those coming under below poverty line but bliss for medical firms. About 70% people in India relies on agriculture for their livelihood. The contributing of agriculture to the GAV has decreased from 18.2 (2014-15) to 16.5% in (2019-20), this decrease shows the decline in share of agriculture sector and relatively higher growth performance in non-agriculture sector. This lockdown initially affected livelihood of poor and farmers beyond repair. However, govt. is trying to restoring the damage and giving relaxation to the sufferers.

20302

70. Farmer Field School Approach

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The Farmers Field School (FFS) approach was developed by FAO and partners in Southeast Asia as an alternative to the prevailing Top-down extension method of the Green Revolution, which failed to operate in situations where the more complex and counter-intuitive are knowledgeable. In FFS the problems existed, such as an insecticide-induced insect outbreak.

In a typical FFS a group of 20–25 farmers meet once a week under the guidance of a local field setting and trained instructor. In groups of five they observe and compare two plots during the entire harvest season. One plot follows local traditional methods, while the other may be used as "best practices". They experiment with key elements of the agro-ecosystem by measuring plant growth, taking pests, weeds and diseased plant samples, and creating simple cage experiments or comparing different soil characteristics. At the end of the weekly meeting they present their findings in a plenary session, followed by discussion and planning for the coming weeks.

Alternative practices are not considered superior to traditional practices. It is up to the farmers to decide what works best through their tests and observations. What FFS does is provide a risk-free setting in which to discuss, dissect, amend, and experiment with new agricultural management ideas.

In this field-based setting, farmers are able to investigate a wide range of topics such as soil fertility and water resources management; Local selection methods and seed quality issues; Risks associated with the implementation of toxic pesticides and low-toxicity alternatives; Development of marketing skills; and diversification of agricultural systems with new crops for food, fodder and profit.

On a national and regional scale, the list of subjects continues to expand. The learning-by-approach approach promotes agro-based experimentation, group organization, and decision making; in this way the possibility increases that the farmers will eventually "own" and adopt better practices.

At the end of the season, a general FFS group holds a field day to show local politicians, government farm workers and other farmers what they are doing. Exchange visits with other FFS are also encouraged. The season-long approach helps build strong social relationships that last after the initial FFS.

Not all topics can be addressed in one session, and FFS groups often continue with new topics and activities in subsequent sessions. Exploring past trends, present situation and future scenario helps groups prioritize needs, interests and actions for the future.

FFS national programs are more than just a collection of FFS. They typically work on multiple scales to build social capital, for example by strengthening productive organizations and contributing to greater organizational capacity

along the entire value chain-ranging from funding, crop processing and marketing till investment. FFS national programs have now begun to work closely with other participatory, community-based initiatives, particularly community audience clubs.

Farmer Area School Facilities

FFS facilitators come from a wide variety of domains. These usually include extension workers, NGO workers, farmer's organization workers or previously trained farmers. Their role is to encourage active exploration and understanding of how agricultural systems work. They introduce new ideas through guided practice and encourage discussion without dominating the view "by farmers, for farmers".

The narrators undergo rigorous, season-long training conducted by "master trainers" and follow a "learning-by-tax" approach by farmers who eventually train at FFS. At the beginning of a country program, master trainers are often brought in from other countries, where there is already sufficient experience; Thereby ensuring the highest possible quality in training through "South-South" collaboration. Facilitators and master trainers ensure contact with district and national level resources helping to improve the flow of information and knowledge exchange.

ENGINEERING AND TECHNOLOGY

20337

71. How Drones Involved in Revolutionizing Agriculture

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Unmanned aerial vehicles (UAVs), higher referred to as drones, are used commercially since the first Eighties.

Today, sensible applications for drone's square measure increasing quicker than ever during a type of industries. Responding to the quickly evolving technology, corporations square measure making new business and operational models for UAVs.

The total available price of drone-powered solutions altogether applicable industries is critical, quite $127 billion, in line with a recent PwC analysis. PwC estimates the marketplace for drone-powered solutions in agriculture at $32.4 billion.

Among the foremost promising areas is agriculture, wherever drones supply the potential for addressing many major challenges.

Soil and Field Analysis

- Drones are often instrumental at the beginning of the crop cycle.
- They turn out precise three-D maps for early soil analysis, helpful in coming up with seed planting patterns.
- When planting, drone-driven soil analysis provides information for irrigation and nitrogen-level management.

Planting

- Drone-planting systems that reach AN uptake rate of seventy-five percent.
- Decrease planting prices by eighty-five percent.
- These systems shoot pods with seeds and plant nutrients into the soil, providing the plant all the nutrients necessary to sustain life.

Crop Spraying from Sky

In industrial farming, it's typically necessary to require to the skies to spray pesticides, drop seeds, or spot dying crops. Drones will drop a way a lot of targeted load of chemical than a conventional heavier-than-air craft might.

- Distance-measuring instrumentality, supersonic reverberant and lasers like those employed in the light-detection and go, or LiDAR, technique allows a drone to regulate altitude because the topography and geographic vary, and therefore avoid collisions.
- Drones will scan the bottom and spray the right quantity of liquid, modulating distance from the bottom and spraying in real time for even coverage.
- As for the result redoubled potency with a

discount of within the quantity of chemicals penetrating into groundwater.
- Consultants estimate that aerial spraying are often completed up to 5 times quicker with drones than with ancient machinery.

Crop and Field Observation

- Immense fields and low potency in crop observation along produce farming's largest obstacle.
- Observation challenges square measure exacerbated by progressively unpredictable atmospheric condition, that drive risk and field maintenance prices.
- Antecedently, satellite imagination offered the foremost advanced variety of observation. however there have been drawbacks. pictures had to be ordered ahead, can be taken just once each day, and were inaccurate.
- Further, services were extraordinarily expensive and therefore the images quality usually suffered on bound days. Today, time-series animations will show the precise development of a crop and reveal production inefficiencies, enabling higher crop management.

Irrigation

- Drones with hyperspectral, multispectral, or thermal sensors will establish that components of a field square measure dry or want enhancements.
- Once the crop is growing, drones enable the calculation of the vegetation index, that describes the density and health of the crop, and show the warmth signature, the number of energy or heat the crop emits.

Health Assessment

- It's essential to assess crop health and spot microorganism or plant life infections on trees.
- By scanning a crop exploitation each visible and near-infrared lightweight, drone-carried device will establish that plants mirror completely different amounts of inexperienced lightweight and NIR lightweight.
- This info will turn out multispectral pictures that track changes in plants and indicate their health. A speedy response that may save a whole woodlet.
- As presently as a illness is discovered, farmers will apply and monitor remedies a lot of exactly.
- Increase a plant's ability to beat disease: within the case of failure, the farmer is going to be ready to document losses a lot of with efficiency for insurance claims

Future of Drones

UAVs may involve fleets, or swarms, of autonomous drones that would tackle agricultural observation tasks conjointly. Hybrid aerial-ground drone actors that would collect information and perform a spread of alternative tasks.

What's Fastness the Progress of Drones in Agriculture?

On the far side the barriers to widespread drone adoption altogether industries, safety of drone operations, privacy problems, and insurance, coverage queries. the largest agricultural concern is that the sort and quality of information that may be captured. Lack of quality and refined sensors and cameras

20381

72. Engineering Principles in Modern Agriculture in India is Inevitable

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Agriculture is the backbone of Indian economic-cultural system, in which agriculture sector is undergoing a transformation driven by new technologies, challenges, information and

methods. The agriculture and allied sector continue to be pivotal to the sustainable growth and development of the Indian economy. Nowadays, new innovations come to agriculture sector for better improvement and utilization of land to improve the quantity and quality of food products for betterment of economic system. Every sector has its own knowledge to modify or to increases its quality by applying good principles or methods or technology. In day to day the farming system, productivity, new invention and different tools are being used in present situation to make agriculture profitability venture. Since, the beginning of agricultural economic reforms in 1991 to present scenario the growth rate shown high volatility.

Different engineering principles of mechanical, electrical, electronic, chemical civil branches can be applied in the agricultural sector to cop up with present demand and requirement of higher production. The major sub division of agriculture engineering farm mechanization, renewable energy, soil and water conservation, irrigation and drainage and post-harvest technology. The principles of the above-mentioned branches will apply to different sub division of agriculture engineering to increase the overall socio-economic status of farmers and helps in overall rural development and it's inevitable in Indian agricultural system. at first farm mechanization is one of the key roles to play right from land development till harvest. Meanwhile in farm machinery, different equipments, implements and machines are used in fields and to increase productivity. It includes land development equipment, primary tillage implements, secondary tillage implements, plant protection implements, inter-cultivation implements, harvesting equipment, threshing cum cleaning equipment and other stationary equipments. Utilization of renewable energy sources like solar energy, wind energy, biomass, geothermal, ocean energy, tidal energy, is essential as the other energy sources are in the state of extinct. In food processing sectors, number of unit operations are used for making different value added products, preservation, quality control, storage and marketing. These unit operations are performed to maintain the food quality, appearance and increase shelf life of products. Whereas in soil and water conservation discipline, the principle mainly involved in planning, development, management of natural resources like land and water and also flood forecasting, drought management, river morphological study and soil and water conservation measures implementation in microwateshed level are included. The sub division also deals with estimating and analysing both surface and subsurface water quantitatively and qualitatively. In irrigation engineering, mainly focus on optimum allocation of water, utilization of irrigation water by different irrigation methods. The drainage engineering branch provides suitable condition for farming practise by removing excess water in order to avoid waterlogging condition.

COMPUTER ADDED TECHNOLOGY

20338

73. Artificial Intelligence in Agriculture

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Artificial Intelligence could be a branch of applied science addressing the simulation of intelligent behaviour in computers. The global population is anticipated to achieve ten billion individuals by 2050, which suggests double agricultural production so as to satisfy food demands that is concerning seventieth increase in food production. Farm enterprises need new and innovative technologies to face and overcome these challenges.

By victimization AI we are able to resolve these challenges

How AI is employed IN AGRICULTURE

- Automatic farming activities.
- Identification of blighter and malady natural event before prevalence.
- Managing crop quality.
- Watching organic phenomenon.
- Abiotic factors and stress.
- Machine vision systems and constitution cause changes.

Automated Irrigation System

Effect of usage

- Reducing production prices of vegetables, creating the trade a lot of competitive and property.
- Maintaining (or increasing) average vegetable yields.
- Minimizing environmental impacts caused by excess applied water and ensuant agrichemical leach.
- Maintaining a desired soil water aim the foundation zone that's optimum for plant growth.
- Low labour input for irrigation method maintenance.
- Substantial water saving compared to irrigation management supported average historical climate.

AI-Remote Sensing: Crop Health Surveillance

- Hyperspectral imaging and 3D optical device Scanning, are capable of quickly providing increased data and plant metrics across thousands of acres with the special resolution to delineate individual plots and/or plants and also the temporal advantage of chase changes throughout the growing cycle.
- Strategies are typically time overwhelming and customarily categorical in distinction to what is analysed through automatic digital detection and analysis technologies categorized as remote sensing tools.
- The trained use of hyperspectral imaging, spectrometry and/or 3D mapping permits for the substantial increase within the range of ascendible physical observables within the field.
- In result, the multi sensing element assortment approach creates a virtual world of constitution knowledge within which all the crop observables become mathematical values.

AI for Picking Vine Crops

- Strategies are typically time overwhelming and customarily categorical in distinction to what is analysed through automatic digital detection and analysis technologies categorized as remote sensing tools.
- The trained use of hyperspectral imaging, spectrometry and/or 3D mapping permits for the substantial increase within the range of ascendible physical observables within the field.
- In result, the multi sensing element assortment approach creates a virtual world of constitution knowledge within which all the crop observables become mathematical values.

Decision Network (DSS) for Field Prediction Victimization AI Techniques

This system involves a group of AI primarily based techniques:

- Artificial Neural Networks (ANNs)
- Genetic Algorithms (GAs)
- Gray System Theory (GST)

Use of artificial intelligence-based strategies offers a promising approach to yield prediction and compared favorably with ancient strategies.

AI -Driver Less Tractor

Using ever-more subtle package plus ready-made technology as well as sensors, radar, and GPS, the system permits associate degree operator operating a mix to line the course of a driverless tractor propulsion a grain cart, position the cart to receive the grain from the mix, then send the totally loaded cart to be dud.

AI For Weeding

The Hortibot is concerning 3-foot-by-3- foot, is self-propelled, and uses world positioning system (GPS). It will acknowledge twenty-five totally different forms of weeds and eliminate them by victimization its weed removing attachments

HortiBotis eco-friendly, as a result of it sprays precisely on top of the weeds. because the machine is lightweight --between two hundred and300 kilograms, therefore it'll not hurt the soil behind it. it's additionally cheaper than the tools presently used for weed-elimination because it will work throughout extended periods of your time.

Conclusion

- AI is applicable and efficacious in agriculture sector because it optimizes the resource use and potency.
- It solves the scarceness of resources and labour to an oversized extent. Adoption of AI is kind of helpful in agriculture.
- AI is industrial revolution and boom in agriculture to feed the increasing human

population of world.
- AI can complement and challenge to form right call by farmers.

ECONOMICS

20250

74. Contract Farming: A Cushion for Future Price Volatility

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Recent announcement of *Atmanirbhar Bharat Abhiyan* economic stimulus package by our Hon'ble Finance Minister ensured a strong legal framework to facilitate contract farming in India. This once again emphasized the importance of contract farming to minimize the risks involved in agriculture for both the producers and buyers in the near future of modern India. It involves agricultural production being carried out on the basis of a pre-harvest agreement (or forward contracts) between the buyers and producers (farmers or farmer organisations). Government has also exempted firms engaged in contract farming from the existing licensing and restrictions on stock limit and movement of foodstuff under the Essential Commodities Act, 1955. A number of studies have shown that contract farming can increase agricultural productivity, profitability and farmers' income, and reduce food insecurity; see, for instance, Wang *et al.* (2014), Bellemare and Novak (2016) and Kumar *et al.* (2016). According to Chand (2005), contract farming's benefits to smallholders, who represent about 80 per cent of the rural population, include access to credit, inputs and extension services. Kumar *et al.* (2018) found that access to institutional credit, extension services, individual ownership of transport and farm size have a positive impact on farmers' participation in contract farming whereas migration has a negative impact.

Legislation Related to Contract Farming in India

- Ministry of Agriculture drafted Model APMC Act, 2003 involving provisions related to registration of sponsors, recording of agreement, dispute settlement mechanism.
  - Consequently, some states amended their APMC acts to provide for it.
- Ministry of Agriculture again drafted a new Model Contract Farming Act, 2018 which encourages states to enact clear laws related to contract farming in line with the model Act.
  - Tamil Nadu became the first state to enact a law in line with it.

Contract Farming Models in India

Eaton and Shephard (2001) classified five major models of contract farming.

1. *Centralized Model*: In this model, the sponsor buys from a large number of small farmers and helps in processing too such as tomato processing by PepsiCo in Punjab.
2. *Nucleus-Estate Model*: It is an extension of the centralized model where the sponsor also manages an estate or plantation. This model is suitable for plantation crops such as tea, coffee, cocoa, oil palm, etc.
3. *Muti-partite Model*: It involves a variety of organisations at different levels of production. For example, the leading firm (Dabur) involved in contract farming with tribal communities for production of medicinal plants; another firm providing input facilities to the farmers.
4. *Intermediary Model*: It involves sponsors in sub-contracting linkages of farmers with intermediaries. There is a danger that the sponsor loses control of production, quality as well as prices received by farmers.
5. *Informal Model*: It involves informal production contracts, usually on a seasonal basis (Prasad, 2013). It is characterized by individual entrepreneurs or small companies. This arrangement is mostly found in fruits and vegetables.

Benefits of Contract Farming

- Protects farmers' interests.
- Ensures private participation in agriculture.
- It improves productivity of farming sector.
- It eliminates intermediaries.
- It leads to better price discovery of crop produce.

- It can enhance export and link farmers to global value chain of food processing.
- Consumers benefit.

Challenges Involved

- Lack of uniformity or homogeneity among states law.
- It promotes regional inequality as developed states reap most of the benefits.
- Landholding pattern - Companies usually prefer large farmers for contractual agreement.
- It increases dependency of farmers on corporate for inputs, making them vulnerable.
- Farmers are denied prevailing high market prices as it is decided beforehand.
- It encourages monoculture farming and impact soil health of land.
- It lays less emphasis on sustainable means of production as fertilisers and pesticides are used to enhance output of produce.

Area under Contract Farming in India

States/UTs	Total cropped area (2003-04) (in '000 ha)	Area under Contract Farming (2007) (in ha)	Area under Contract Farming (upto April 2010) (in percentage) *
Andhra Pradesh	12366	-	66** (of total horticulture area)
Assam	3962	160	-
Bihar	7882	20	-
Chhattisgarh	5707	-	-
Goa	169	1924	-
Gujarat	11311	2000	-
Haryana	6388	1416	0.24 (of total area under barley)
Mizoram	98	2447	-
Odisha	8637	5900	28.30***(of total area under cotton)
Punjab	7931	121457	1.05
Tamil Nadu	5316	236610	Negligible (oil palm only)
West Bengal	9707	-	Negligible
India	190641	425834	-

Note: As reported by different states, **: Under horticulture crops, ***: Area under cotton.
Source: http://www.indiaagristat.com/table/agriculture/2/agriculturalarealanduse

The above table gives information about the area of contract farming in the different states and total area in India in the year 2007. Highest area is in Tamil Nadu and total area under contract farming in India is 425834 ha.

Way Forward

There are clear advantages for farmers in contract farming as it offers them with hassle-free production process for potatoes or any other produce in a public-private partnership mode. It gives them a secure and steady source of income. Many case studies of farmers have pointed that the farmers are satisfied with their ventures with big corporations and firms as it leads to relatively risk-free farming and a cushion against future price volatility. Government can also undertake various policy measures to encourage contract farming such as tax exemption for food processors involved, can provide enabling environment by enabling competition and bridging information asymmetries between farmers and buyers. However, the drawbacks need to be addressed in a comprehensive manner before undertaking widespread implementation. Finally, all states should adopt and implement Model Contract Farming Act, 2018 to provide conducive scenario for promotion of contract farming. There is widespread scope of contract farming in India in the near future which will not only enhance farmers' income and productivity but also reduce post-harvest losses of perishable agricultural commodities and help in commercialisation of agriculture sector on a large scale. It will also lead to enhanced contribution of agriculture sector in the GDP of our country.

References

Bellemare, M. F., and Novak, L. 2016. "Contract Farming and Food Security." American Journal of Agricultural Economics 99(2): 357–378. doi:10.1093/ajae/aaw053.

Chand, R. 2005. India's Agricultural Challenges: Reflections on Policy, Technology and Other Issues. New Delhi: Centre for Trade & Development. http://www.centad.org/images/download/agricultural_book.pdf.

KB, Ramappa & A.V., Manjunatha. (2016). PRESENT STATUS AND PROSPECTS OF CONTRACT FARMING IN INDIA. International Journal of Agriculture Sciences. 8. 1072-1075.

Kumar, A., Roy, D., Tripathi, G., Joshi, P K., and Adhikari, R. P. 2016. "Can Contract Farming Increase Farmers' Income and Enhance Adoption of Food Safety Practices? Evidence from Remote Areas of Nepal." IFPRI Discussion Paper No. 01524. Washington, DC: IFPRI.

Kumar, Anjani; Tripathi, Gaurav; Roy, Devesh; Joshi, Pramod Kumar; and Karandikar, Bhushana. 2018. Impact of contract farming on profits of smallholders: Evidence from cultivation of onion, okra, and pomegranate in India. IFPRI Discussion Paper 1787. Washington, DC: International Food Policy Research Institute (IFPRI). http://ebrary.ifpri.org/cdm/singleitem/collection/p15738coll2/id/133037

Wang, H. H., Wang, Y., and Delgado, M. S. 2014. "The Transition to Modern Agriculture: Contract

Farming in Developing Economies." American Journal of Agricultural Economics 96(5): 1257–1271. doi:10.1093/ajae/aau036.
https://www.thehindu.com/business/Economy
http://www.fao.org
https://www.ifpri.org/
https://www.prsindia.org
https://vikaspedia.in
http://www.visionias.in/

20261

75. Direct Agriculture Marketing: Closing the Price Gap

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Direct Marketing

Direct marketing in agriculture means markets where farmers directly transact with the produce consumers. These operate in two basic formats (i) Farmers' Markets, and (ii) Direct sourcing from farmer's field by processors (primary consumers). These markets are proven beneficial to both producers and consumers. These markets have helped in mitigating the problems of the fragmented supply chain. Further, the quick movement of produce from farmer to consumer saves losses considerably.

Objectives of direct marketing

1. To enable the farmers as primary producers to realize the best possible benefits.
2. To provide facilities for all the produce the farmers are willing to sell, at a price incentive.
3. To reduce the price spread.
4. To make available all products of farm origin to consumers at a reasonable price without impairing the quality of the produce.

In direct markets, no market fee is charged but service charges are collected from sellers. About 488 such farmers' markets are operating in different States in the name of Apni Mandis in Punjab and Haryana, Rythu bazaars in Andhra Pradesh and Telangana, Uzhavar Sandhai in Tamil Nadu, Shetkari Bazaars in Maharashtra and Raitha Santhe in Karnataka. Direct marketing and direct sourcing allow farmers to skip multiple layers in their transactions and generate benefits by skipping of intermediary margins. Though recommended in the Model APMC Act & Rules, very few of States have issued such licenses for direct sourcing. Traditional marketing of fruits and vegetables is unfavorable for farmers as a major share of consumer rupee is pocketed by the traders. The farmers get a low price for their produce whereas the consumers have to pay a higher price for poor quality products available in the markets. Thus, a concept of was developed to facilitate direct marketing between consumers and farmers, for a direct interface between the farmers and the consumers eliminating middlemen. The government has issued licenses for operation of direct markets for many states. The number of licenses issues to different states are depicted in table 1.1 below-

Table 1.1 State-wise licenses issued for Direct Marketing

SN	Name of State	No. of Direct purchase licenses issued
1	Madhya Pradesh	1
2	Andhra Pradesh	2
3	Gujarat	3
4	Rajasthan	3
5	Telangana	3
6	J&K	3
7	Punjab	11
8	Himachal Pradesh	12
9	Karnataka	37
10	Maharashtra	219

Source- Doubling Farmers 'Income Vol-IV

Advantages of Direct Marketing

- In these markets small scale farmers can sell directly to the consumers, thereby eliminating middlemen, who were exploiting both farmers and consumers alike.
- The direct sale results in the farmer getting a better price.
- It provides good quality fruits and vegetables at reasonable price daily.
- It gives full satisfaction to the farmers and the

public.

References

Doubling Farmers' Income – Volume IV Post-production interventions: Agricultural Marketing

https://www.livemint.com/Politics/kejX5POEUKK1l7qz05c0VL/How-Maharashtra-is-changing-the-way-farmers-sell-their-produ.html

http://agritech.tnau.ac.in/agricultural_marketing/agrimark_Farmers%20market.html

20364

76. Export Potential of Indian Tea

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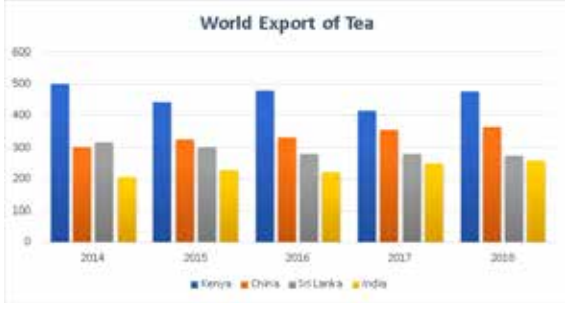
Tea in India is not only a beverage but it's an emotion as it forms an important part of our daily routine. A country where 80 per cent of the population takes tea with or before their first meal of the day earns this plantation crop a significant position on India's consumption map. Tea is regarded as "any time of the day" drink. Tea is a popular beverage around the globe as it is one of the oldest and most widely consumed cheap beverage after water. This non-alcoholic beverage is consumed by individuals of all strata of society irrespective of their age and financial status. Different types of tea such as green tea, black tea, herbal tea, white tea, oolang tea and yellow tea are available in the market. The other major tea exporting nations are Kenya, China and Sri Lanka. World export of tea has recorded a compound growth rate of 27 percent from 1991 to 2018, as the exports increased from 1078.17 million kg in 1991 to 1858.82 million kg in 2018. The top four tea exporting nations as shown in graph accounts for about 73 percent of total world tea export.



Source: Annual Bulletin, Tea Board of India

Indian Scenario

India is the second largest producer of tea after China, producing 1338.63 million kgs in 2018 which was nearly 23 percent of total global produce and is the largest consumer of tea as it consumes 21 per cent of total world tea consumption. This depicts that nearly 80 per cent of the tea produced in consumed domestically. Our country exported 256.06 million kgs of tea in 2018, which was 13.7 percent of total global exports, making it the fourth largest exporter nation of tea. The total tea exports of India are of worth US$ 830.90 million in 2018-19, the major importers of Indian tea were Iran (US$ 131.77 million), CIS (US$ 90.29), USA (US$ 37.35 million), UK (US$ 30.97 million), UAE (US$ 25.30 million) and China (US$ 21.70 million). In the last decade India's export values for supplying tea in the countries of Vietnam, Thailand and Iran have increased at the compound growth rate of 42.89%, 36% and 8.71% respectively. In 1950s, India dominated the world tea market as it was the largest supplier exporting 230 million kg of tea annually. With increase in income, increased awareness about health benefits of tea, cheap rates and easy availability of tea lead change in rise in domestic consumption of tea. Increased domestic consumption decreased the exports.

The country is home to a wide variety of teas, including CTC tea, orthodox tea, green tea and organic tea. Unlike many other teas producing and exporting nations, India has a manufacturing base for both CTC and orthodox tea, in addition to green tea. India offers high-quality specialty teas, such as Darjeeling, Assam Orthodox and the high-range Nigiri, which have a distinctive aroma, strength, colour and flavour. Indian tea industry is a labour intensive industry providing direct employment to over 1 million persons and indirectly it provides food to 10 million people through forward and backward linkages. The tea industry in India is a symbol of women empowerment as it is the industry that employs women comprises 51 percent of the total workforce. Majority of the tea estates are located in backward areas of North Eastern India thus tea industry not only earns foreign exchange but also acts as a medium to uplift the socio-economic status of the people of these regions.

Trade Competitiveness of Indian Tea in Global Market

Many researches had been done to study the global competitiveness of Indian tea. One of the studies carried out by *Sneha, 2019* reveals that Indian tea confirms a prominent competitive position in world tea trade in comparison to agricultural trade. The analysis shows that India has managed to retain its position in the top four tea producing nations and there exist a lot of potentials in the Indian tea industry. Though the Indian subcontinent has witnessed a fall in its position in tea exports from first rank in 1950s to fourth rank at present, it still produces a large portion of the total world tea and with increasing area under this plantation crop projects India's potentials to top the export charts again. In recent times the rise of two small countries like Kenya and Sri Lanka in global tea market surpassing their geographical and economical conditions possess threat to Indian tea. Moreover, the change in consumption pattern of consumers towards green tea boosts the Chinese tea market. Thus, to meet the rising domestic and global demands adoption of new advanced technologies is required to increase the productivity of the crop, strategies to promote the health benefits of tea to attract the non-conventional areas of tea in the world for an expansion in the consumption of tea.

References

Chaudhary, Sneha. (May, 2019). Export competitiveness of Indian tea industry. *International Journal for Research in Engineering Application & Management*, 5(2):318-323.

Das, Pallavi and Zirmire, Jyoti. (2018). Tea industry in India: Current trends and future prospective. *Journal of Pharmacognosy and Phytochemistry*, 7(1):407-409.

Wagh, Ashok. (December, 2014). Indian tea industry: It's status in global scenario. *Abhinav International Monthly Refereed Journal of Research in Management and Technology*, 3(12):32-36.

www.teaboard.gov.in

www.ibef.org

20374

77. Pradhan Mantri Fasalbima Yojana (PMFBY): Analysis and Achievement as "One Nation, One Scheme"

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Farmers face drought, flood, and severity of pest and diseases coupled with other natural disasters. The weather adversary is of great concern as humans cannot control over it. Farming is practiced since the start of civilization. But as time evolved, need and structure of farming had undergone a lot of changes, with the development of technology the humans are able to tackle the risk that arises due to the weather condition.

Crop insurance originated as a tool to help farmers to pass the weather risk to the third party on payment of some premium. But this concept is not new, its origin can be traced back to the18th century in Germany where government used to insure against the hailstorm and from there it spread to other countries. The government of India officially started crop insurance in 1985 with the launch of the Comprehensive Crop Insurance Scheme (CCIS). Later in 1999, the National Agriculture Insurance Scheme (NAIS) was launched to overcome the lacunaes in CCIS. But NAIS end up with own limitation like premium do not equal risk level, lofty financial goals etc. Later Weather Based Crop Insurance Scheme and Modified National Agriculture Insurance Scheme brought in to action but, they were not on par with the farmer's expectations.

As it was evident that the Indian government was failing to provide a holistic insurance scheme. In this scenario, Pradhan Mantri Fasal Bima Yojana (PMFBY) was launched in February 2016 by merging National Agriculture Crop Insurance Scheme and Modified National Agriculture Insurance Scheme, with the aim to enhance the sustainable production in the agricultural arena by:

1. Compensating the effect of natural calamities covering localized calamity too.
2. To keep the farmer's income on par with the changing needs of agriculture so they can carry forward the agricultural practices with ease.

3. By supporting the farmers to adopt new innovative technology.
4. To regularize the credit flow in agriculture which further contributes to the food security, diversification of crops at farm level resulting in increase the efficiency and competitiveness of agriculture sector, on the other hand, protection of farmers from the production as well as natural risk.

Features of PMFBY

PMFBY was launched with the slogan "One Nation, One Scheme" and some of its important features are given as:

1. **Premium Rates**: The premium rate for a particular season's crops is fixed *i.e.* for kharif crops 2%, for rabi crops 1.5% and for horticulture crops 5% with no limit on government subsidy.
2. **Farmers coverage**: The scheme is mandatory for the loanee farmers but voluntary for the non-loanee farmers, tenants, and the sharecroppers. Also, it has increased the coverage in the North-Eastern region so the farmer can do away their agriculture risks.
3. **Risk Coverage:** It covers the risk ranges from planting to harvesting even the post-harvest risk also covered. Also, the insured sum equalizes the cultivation cost per hectare multiplied by the proposed area of the crop.
4. **Area-based approach**: PMFBY is based on the area approach which is helpful to provide the same premium for the affected area and the claim amount is also the same.

PMFBY: Achievements and Comparison with its Predecessors

1. Premium rate: Premium rate is low and fixed for the season *i.e.* 2% for Kharif crops, 1.5% for Rabi, and 5% for the horticultural crops which is very less with respect to the premium rate of Modified National Agricultural Insurance Scheme (MNAIS) *i.e.* 9-15%.
2. There is no upper limit in the subsidy even if the balance premium is 90% but the insurance amount was capped in the MNAIS.
3. Post-harvest losses coverage was covered for all Indian states while in MNAIS it was only for the coastal areas.
4. The use of technology is mandatory in PMFBY which was intended in MNAIS and absent in NAIS.
5. Prior to PMFBY the insurance schemes were claim based insurance scheme but PMFBY allows subsidy in the premium-based system to be implemented through the multiagency and bring more transparency.
6. PMFBY insured 30% gross cropped area till 2018-19 but just meagre 28% coverage of farmers achieved under combined WBCIS+NAIS+MNAIS.

Table 1: Year-wise coverage of PMFBY

Season	Farmer Application (million)	Gross premium (Rs. billion)
Kharif 2016-17	40.60	163.61
Rabi 2016-17	16.70	58.28
Total 2016-17	57.30	221.90
Kharif 2017-18	33.30	191.58
Rabi 2017-18	15.20	52.57
Total 2017-18	48.50	243.85

Source: Business Standard.com

The provisional gross premium for 2018-19 was 20923 crores (PIB). The area under cultivation insured increased to 54.7 lakh hectares in 2018-19 from 50.4 lakh hectares in 2017-18

7. There was no target for awareness in NAIS and Modified NAIS but in PMFBY target is to double the coverage up to 50%

PMFBY: Challenges and Issues

The PMFBY owes its identity as an innovative and transformative approach to insurance but the scheme faces challenges and issues that is making the economy distrust in the economy. Some of them are discussed below:

1. As states can voluntarily choose to implement PMFBY and also, they can notify the crops but ambiguity is regarding the procedure to select the major crops by state agencies.
2. As a mandatory credit linked scheme, the trust element within farmers' community is decreasing which can be seen as the number of insured farmers decreased by 14% from 2016 to 2017.

Table 2: Number of loanee and non-loanee farmers insured under PMFBY for Kharif crops

Year	Total farmers (in Lakhs)	Non-Loanee Farmers (in Lakhs)	Loanee Farmers (in Lakhs)
2016	390.50	101.30	289.20
2017	335.80	106.60	229.20
2018	324.50	120.60	203.90

Source: www.factly.in

3. Despite being a yield protection scheme, it is unable to consider revenue protection which makes the farmer at loss in the end of the season due to low wholesale price exist in the market.
4. High expenditure from the public sector because the scheme is mainly based on the subsidy, not on commercial sustainability so it

can create problems in the long run.
5. The financial crisis hovering around India's state revenue also becomes a cause of concern with respect to claims made by farmers.

PMFBY: Assessment as "One Nation One Scheme"

From the above discussion, it can be said that PMFBY is a breakthrough transformative scheme and also large coverage of farmers with a wide beneficiary range over the pre- existed scheme. But it is also had some inherited lacunas at implementation level which are need to be considered and get solved.

So, the PMFBY will fulfil its purpose to unite nation into one scheme and become the ray of hope for the farmer community.

Recommendation

1. Strict guidelines for compliance with the claims delay. As per new guideline 12 % penalty on insurance company for delay in claim settlement is a welcome step towards the cause in Modified PMFBY.
2. Still Crop Cutting Estimation is prevalent in many states for crop yield estimation which is highly manipulated as the insurance companies are profit driven. So, need to engage new tech like satellite images, remote sensing etc to measure the insurance amount.
3. A well-advanced grievance redressal system needs to be associated with the PMFBY so the problems faced by the farmers can be solved in time.
4. Integration of PMFBY with other agriculture development scheme can be acts as "cherry on the top", so the farmer can get holistic services.

References

DTE Staff (2017, July 31), Pradhan Mantri FasalBima Yojana is a good scheme with flawed execution.

Economy Survey (2019-20), Ministry of Finance, http://www.prsindia.org

Ghosh, S. (2019). An Analysis of Pradhan Mantri FasalBima Yojana (PMFBY): Expectation and Reality. International Journal of Advanced Science and Technology, 28(20), 788-794. Retrieved from http://sersc.org/journals/index.php/IJAST/article

Pradhan mantra FasalBimaYojana (2017), Centre for science and Environment.

Rai, R. (2019), Pradhan Mantri FasalBima Yojana: Assessment of India's crop insurance scheme, ORF Issue brief no. 296, Obsever Research Foundation.

World Bank collection of development Indicator (2019), http://www.tradingeconomics.com

AGRIBUSINESS

20251

78. Collosal Harvest from Tiny Plants: Micro Greens

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As days in the calendar will change similar to that consumer's needs are also changing rapidly in this dynamic environment. Now a day's awareness towards health among people is increasing day by day. There is an increased demand for nutritious food especially for organic foods and the food which is having all kinds of nutrients, essential elements, and vitamins. Foods like sprouts, microgreens and baby greens are becoming popular due to their nutritional values and they can meet the requirements and satisfy mainly the health-conscious customers.

Micro-greens are new to the market and it is in budding stage throughout the world. Microgreens are tiny, tender, crunchy, multi super packed nutrient food, found in a pleasing palette of colors one that can germinate in soil or without soil (Hydroponics). They are not similar to sprouts; it is the next stage of sprouts and they are bigger than sprouts but smaller than baby greens. They are having a wide range of flavors, colors and textures. Micro-greens were listed on chefs' menus since 1980, in San Francisco, California. They are gaining popularity as a new culinary ingredient and are used to enhance salads or as edible garnishes, soups, sandwiches, juices, plates and in some vegan recipes to embellish a wide variety of other dishes. Due to higher price points at retail, microgreens are considered as a premium product.

Fig 1. Micro-greens

Microgreens are harvested at seedling stage *i.e.* 7 to 14 days after germination and the harvesting stage varies depending on the species grown when the cotyledons are fully developed and before the true leaves start to grow. It will be having a mono central stem that can be harvested with scissors or we can pluck them with the help of hand. They can be grown commercially or in home. They will fit as an emergency crop at the time of alarming situations in the surroundings.

The nutritional value of micro-greens is being verified through scientific research. According to some latest studies, the vitamin and mineral levels were observed to be beyond completely grown vegetables by almost greater than forty-five times. Micro-greens are well packed by several vitamins and minerals such as ascorbic acid, β-carotene, lutein, zeaxanthin, violaxanthin, Phylloquinone, α-tocopherol and γ-tocopherol. They are also perceived to have environmental benefits over other vegetables as they require less water and energy to produce and they can be produced round the year.

Microgreen Entrepreneurs in India

Krishi cress a startup in Delhi started by Chef Achintaya who was trained as a chef from international culinary center, New York and studied restaurant management and came back to India to work. One day he gave a handful of seeds to his gardener and asked him to grow that seeds in his father's farm. Surprisingly the crop grew very well and it was having a good texture and flavor. He took the greens to his work place and used it on his dishes. Owning to good taste and fragrance he decided to grow them commercially and marketing them to the five-star restaurants with a price quote of Rs. 150/50gms. Initially he sold micro-greens of mustard and radish. Later word of mouth, increased his sales gradually. He has expanded his product line with the inclusion of sunflower, coriander, mizuna, earning a considerable profit from microgreens.

Akhil Nichani was an electronic engineer, a 23-year-old founder who inspected rows of greens jostling for space in their plastic containers. He studied and learned more about microgreens and asked his mother for mustard seeds for experimenting. He supplied to hotels like Crowne Plaza and Radisson Blu, Hotel GRT, The Summer House Eatery, Patina, Broken Bridge Cafe, Radio Room, Lord of The Drinks and Soul Garden Bistro. He offered the greens like radish (red, white, pink and purple), amaranth (red and green), bok choy, cauliflower, cabbage, mustard, clover and broccoli.

Vidhyadharan Narayan an entrepreneur from Chennai had seen potential in growing these nutritious greens as a business six years ago. In 2018 officially he named his business as **Sakhi Microgreens**. Initially he started with an investment of Rs. 15000, now he is earning a bag full of profits around Rs. 80000/month within a 10×10 Room. He supplied micro-greens to super markets and restaurants. He offered around micro-greens such as sunflower, radish, beetroot, amaranth, broccoli, cabbage, alfa-alfa and mustard.

Fig 2. A rack of Micro-greens

Growing greens was a startup by Sagi and

Hamsa who were doing IT jobs in Infosys. They did market research before starting Growing Greens. Initially they started with growing micro-greens in terrace and expanded gradually to four acres of land.

New Business Approaches with Micro Greens

By utilizing the technology and by identifying the un meet needs of consumers so many startups have come into limelight by adopting some ideas:

- Offering Microgreens kit for household purpose. This will help the people who are interested to grow their own food in their own premises.
- Providing training for the young budding entrepreneurs who are interested to start this business.
- Some of the websites are now offering the paid online courses for microgreens training with a certification course which helps to do things in a scientific way.
- Selling the seeds, trays, spraying equipment's required for growing micro-greens.
- Offering micro-green products in health service sector could improve the reach and consumer popularity on micro-greens very soon.

References

Kumar, Sanjeev. (2018). Microgreens: A New Beginning towards Nutrition and Livelihood in Urban, Peri-Urban and Rural Continuum.

Lester, Gene & Xiao, Zhenlei & Luo, Yaguang & Wang, Qin. (2013). Microgreens: Assessment of Nutrient Concentrations.

https://agresearchmag.ars.usda.gov/2014/jan/greens

https://static1.squarespace.com/static/59a566808419c2c20ebc2768/t/5bec6f7840ec9a4b55d39143/1542221690715/Microgreens+with+big+potential_CaseStudy.pdf

BIOTECHNOLOGY

20231

79. Quantitative Real-Time Polymerase Chain Reaction (QRT-PCR)

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Quantitative Real time polymerase chain reaction (qPCR or qRT-PCR) technology is the extension of PCR (polymerase chain reaction). It is a technique that is used to immediately amplify and quantify a specific DNA molecule. It can be used for analysis of gene expression in plant species, with the combination of reverse transcription. It can be used to find out the copy number and quantity of the target molecule in samples. In this technique, the incorporated reagents emit fluorescence with the synthesis of DNA product (amplicon). Increase in amplicon concentration in PCR mixture is measured after each cycle by measuring the quantity of fluorescence emitted within the reaction. The initial concentration of amplicon is measured by threshold cycle (C_t).

Fluorescence technologies are broadly classified into two categories: double stranded DNA (ds-DNA)- fluorescent dye and fluorescent molecular probes. In dsDNA fluorescent dye, specific dyes (*e.g.* SYBR green) are incorporated into amplicons during qPCR reaction, which give fluorescence during binding. The binding and fluorescence are completely random. The binding can occur with any double stranded product, which sometimes provides misleading and non-specific results. Fluorescent molecular probes are more precise and commonly used method in qPCR. In this method, oligonucleotides are attached with fluorophores to one end and fluorescence quencher to other. A probe is specific and complementary to the target molecule. The mechanism is based on separation of fluorophore from quencher with the 5' nuclease activity of DNA polymerase that produce fluorescence. Other examples of probe-based fluorescence are LightCycler hybridisation and LUX fluoregenic hairpin probes; which provides fluorescence with binding to target molecule. Real time PCR is the best technique to analyse the definite gene expression at large scale (Fitzgerald and McQualter 2014). This technique is used to fulfil the study of specific gene expression with high accuracy and time effectiveness in various tissues and at various developmental stages.

Assay design: To achieve the maximum amplification efficiency, various recommendations are considerable, as follows:

1. **Primer design:**
   a) Primer length should be 20-30 base pairs (bp) long.
   b) Preferable amplicon size in between 100-200bp.
   c) To achieve optimum amplification efficiency, annealing temperature of primers should be 55-65°C.
   d) To avoid nonspecific binding, stretch of identical nucleotides should not be greater than four.
2. **Sampling and storage:** Sampling of plant tissue and immediate storage at -80°C is recommended to avoid the degradation of RNA. During RNA extraction, care should be taken to avoid the RNase activity. To achieve efficient RNA extraction, extraction surface should be sterile and sterile solutions should be used.
3. To avoid genomic DNA contamination during cDNA synthesis, RNase free DNase reagents can be used. These reagents can remove traces of genomic DNA from RNA samples.
4. To avoid technical variation in qPCR, cDNA synthesis and qPCR reactions should be considerable. For cDNA synthesis, oligo-dT and random hexamer primers can be used, that affect cDNA composition. The standard preparation methods should be same for all the samples. In case of qPCR reaction, plate to plate variations are considerable. Therefore, care should be taken during planning of experiment.
5. **Normalization of results:** Normalization is the process for adjustment of measured values on common scale. Two forms of qPCR quantification methods are used, relative quantification and absolute quantification. Relative quantification is assessed with respect to stable reference (housekeeping gene). Housekeeping genes are DNA fragments that are expressed in all tissues and during all developmental stages of plants. Amplification efficiency is the main considerable factor for the relative quantification of reference and target genes, which is expressed in the form of Ct values. Absolute quantification depends on the standard curve Ct values for the analysis of serially diluted template DNA. The absolute number of target molecule can be determined by comparison of sample values with the standard curve values.
6. **Softwares used for data analysis:** Various softwares named as LinRegPCR, qBasePLUS etc. are used for qPCR data analysis (Hellemans *et al* 2007). These softwares are mainly used to calculate the reaction efficiencies and optimal combinations of genes to normalize the data from multiple reference genes.
7. **Data representation:** Analysed qPCR data is presented in the form of mean ± standard deviation, at various confidence levels.

References

Fitzgerald, T.L. and McQualter, R.B. (2014). The Quantitative Real-Time Polymerase Chain Reaction for the Analysis of Plant Gene Expression. Cereal genomics*: Methods and Protocols*, Methods in Molecular Biology, vol. 1099, DOI 10.1007/978-1-62703-715-09.

Hellemans, J., Mortier, G., De Paepe, A. *et al.* (2007). qBase relative quantification framework and software for management and automated analysis of real-time quantitative PCR data. *Genome Biology*. **8:** R19.

20256

80. A Brief Note on Biological Database

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Biological Database

A database is a computer archive used to save and organize data facts in such a way that information can be retrieved without problems via a variety of search criteria. With the advent of genomic research, huge quantity of raw protein or DNA sequence data facts are being generated from different and unique biological organism. To manage this huge biological data facts, computational methodologies are required to manipulate and put it to use effectively. Therefore, for proper storage and retrieval of biological data facts, biological data bases are utmost importance.

Classification of Biological Database

(I) Primary database

Primary databases include original biological statistics. They are files of unprocessed raw

sequence or structural information submitted by scientific community. It consists of nucleic acid databases i.E EMBL (European Bioinformatics Institute), DDBJ (DNA Data Bank of Japan), Gene Bank, dbEST and Protein Databases *i.e.*, Protein Data Bank (PDB).

(II) Secondary database

Secondary database contains computationally processed datafacts based totally upon the original data. It consists of Protein Information Resources (PIR) which is the first Protein repository, Swiss Port – Structure, Function and Protein family datafacts and TrEMBL - a database of translated nucleic acid sequences stored inside the EMBL database. A current effort to combine SWISS-PROT, TrEMBL and PIR caused the creation of the UniProt database. Other databases like Pfam and Blocks databases aligned protein sequence statistics.

(III) Specialized database

Specialized databases are those which are related to a particular study of interest. Examples of some specialized databases are FlyBase - A database of the Drosophila genome, HIV databases of HIV series information and related immunologic information, Microarray gene expression database of DNA microarray datafacts and analysis tools, OMIM - Genetic statistics of human diseases, Ribosomal database project of Ribosomal RNA sequences and phylogenetic trees derived from the sequences, SRS- General series retrieval gadget and TAIR-Arabidopsis data database.

Biological Database - Genbank

The GenBank sequence database is an open access, annotated collection of all publicly available nucleotide sequences and their protein translations. This database is produced at National Center for Biotechnology Information (NCBI) as part of the International Nucleotide Sequence Database Collaborationor (INSDC). GenBank is built by using direct submissions from laboratories, as well as from bulk submissions from large-scale sequencing centers. Direct submissions are made to GenBank using BankIt link, which is a Web-based form or by the submission gateway, Sequin. The submissions are then released to the general public database in which the entries are retrievable by way of Entrez or downloadable with the aid of FTP (File transfer protocol). Bulk submissions of Expressed Sequence Tag (EST), Sequence-tagged site (STS), Genome Survey Sequence (GSS) and High-Throughput Genome Sequence (HTGS) data are most often submitted by large-scale sequencing centres.

Biological Database - Uniprot

The Universal Protein Resource (UniProt) is a comprehensive resource for protein sequence and annotation information. The UniProt databases are the UniProt Knowledge base (UniProtKB), the UniProt Reference Clusters (UniRef), and the UniProt Archive (UniParc). The UniProt Metagenomic and Environmental Sequences (UniMES) databases are the repository specially evolved for metagenomic and environmental statistics. UniProt is collaboration between the European Bioinformatics Institute (EBI), the Swiss Institute of Bioinformatics (SIB) and the Protein Information Resource (PIR). The UniProt Knowledgebase (UniProtKB) is the vital hub for the collection of functional statistics on proteins, with accurate, steady and wealthy annotation. In addition to taking pictures the core statistics mandatory for each UniProtKB entry (mainly, the amino acid sequence, protein name or description, taxonomic data and citation statistics), as much annotation records as possible is added. This includes broadly accepted organic ontologies, classifications and cross-references, and clean warning signs of the quality of annotation in the form of proof attribution of experimental and computational information.

Biological Database - Protein Data Bank

The Protein Data Bank (PDB) is a repository for the 3-D structural statistics of massive biological molecules, such as proteins and nucleic acids. The records, generally received by X-ray crystallography or NMR spectroscopy and submitted by way of biologists and biochemists from around the world, can be accessed at no fee on the internet. The PDB is the Worldwide Protein Data Bank. The PDB is a key resource in areas of structural biology, such as structural genomics. Most important scientific journals, and some funding agencies, such as the NIH in the USA, now require scientists to submit their structure information to the PDB.

Plant Genome Database

Availability of correct or nearly correct entire plant genome resource assets is one of the prerequisite conditions of in-silico research. Though, a huge range of scattered plant genome databases are available in the public domain, their reliability and accuracy are an issue of concern. Two critical plant genomes, Arabidopsis (TAGI, 2001) and Rice (IRGSP, 2005) had been completely decoded and their sequences are available within the public domain.

Arabidopsis thaliana (thale cress) genome databases - TAGI, 2001

1. **MATDB** - MIPS, *A. thaliana* database,

Munich, Germ - www.mips.gsf.de/proj/thal/db
2. **KAOS** - Kazusa Arabidopsis at Kazusa DNA Research Institute, Japan
3. **TIGR** - Arabidopsis thaliana Database - The Institute of Genomic Research, Rockeville MD, USA - www.tigr.org.tdb.e2k1/ath1/
4. **AGA** - Arabidopsis Genome Analysis - Cold Spring Harbor laboratories, USA - www.cshl.org/

Oryza sativa (rice) genome database - IRGSP, 2005

1. **RGP** - Rice Genome Research Programme, Japan - www.rgp.dna.affrc.go.jp/IRGSP/
2. **Gramene** - Comparative mapping resource for grains - www.gramene.org
3. **INE** - Integrated Rice Genome Explores; IRGSP, Japan

References

Xiong, J. (2006). *Essential bioinformatics*. Cambridge University Press.
Arthur, L. M. (2002). Introduction to Bioinformatics Oxford University Press 283p.

20318

81. Microfluidics: An Analytical Approach of Biotechnology Engineering

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Introduction

Microfluidics is combination of two words *i.e.* Fluidics (handling of liquids and/or gases) and Micro (has at least one of the following features: Small volume, Small size, Low energy and consumption). Microfluidics is the engineering science which deals with the study nano- and sub-nanoliter range and / or which make explicit use of the effects which are typical for fluids interacting with microstructures or Microfluidics is the science of manipulating fluid flow through channels having dimensions of less than 1 mm.

Why microfluidics is important? Because this process is user friendly, faster, consume low power and portable.

Few technologies used in molecular microbiology are as follows in table 1.

TABLE 1. Few technologies of microfluidics which directly concerns with molecular microbiology area.

Few Technologies	Uses
A microfluidic chip	It integrates many molecular biology processes including reverse transcriptase, PCR amplification, and gel electrophoresis to accomplish the task of detection. The device miniaturizes and integrates three key molecular biology processes: reverse transcription, polymerase chain reaction (PCR), and gel electrophoresis.
Highly parallel sequencing on a wafer	DNA sequencing was performed on a silicon wafer which is analyze 96 samples in parallel in one time. It has great potential to reduces the cost of resequencing and SNP detection.
A micro-PCR device with integrated heaters	6-minute micro-PCR is one of the examples of microfluidic version of device. In 20 min. the thermal cycles is completed in PCR reaction but this time was reduced by Neuzil's group to less than 6 minutes by using integrated silicon heaters and small reagent volumes.
A microfluidic DNA biochip with recirculation capabilities	This method was used for detecting a quantifying infectious agent by hybridizing PCR amplified products to oligonucleotide probes. This process is cost effective as well as sensitive and screen 20 different pathogens in one run.

Applications of Microfluidics

1. **Chemical synthesis:** Microchannels is a typical form for chemical synthesis with lateral dimension below 1 mm and it offers many advantages over the large one viz., reaction speed ine high, its scalability and safety.
2. **Microbes flows:** Microbial flow concerns with liquid environments where microbes frequently experiencing fluid flow *e.g.* microbes flow in oceans, river groundwater,

as human microbiota, biofuel production, nutrient uptake by fertilization process.

3. **Separation and analysis:** Microfluidics with respect to separation and analysis, electrophoresis is one of the good examples which helps to detect the migration behavior between charges species. It is highly versatile technique for separation of biological macromolecules.
4. **Biodetection:** Food quality, biological weapon detection and medical diagnostics are examples of biodetection and main aim of these devices to miniaturize and parallelize immunologic and genomic detection assays.
5. **Single cell biology:** It is physical domain and used for cell biology study mainly w.r.t. spatial control of liquid composition viz., subcellular resolution, fast media and temperature changes, single cell handling and analysis. It enables studies from single to multicellulae organisms' level.
6. **Microbial navigation: Chemotaxis, aerotaxis,** thermotaxis, galvanotaxis, and magnetotaxis are the best examples of microbial navigation where we study the motility of microbes and their response to cues from the environment.

20339

82. Biosensors

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A biosensor is a device containing an immobilized biological material (enzyme, antibody, hormone, cell organ or whole cell) which might specifically react with analyte and resulted in physical, chemical or electrical signals which will be measured. Analyte may be a compound (*e.g.* glucose, urea, drug, pesticide) whose concentration should be measured.

Components of a Biosensor

- Sensor
- Transducer
- Amplifier
- Processor
- Display unit

Sensor

It is a sensitive biological part (biological material (*e.g.* tissue, microorganisms, organelles, cell receptors, enzymes, antibodies, nucleic acids, etc).

Transducer

Transducer may be a device that converts energy from one type to a different type. In biosensors transducers convert the organic chemistry activity into voltage.

Principle

Biosensors are operated supported the principle of signal transduction. Bioreceptor, is allowed to act with a selected analyte. The electrical device measures this interaction and outputs a proof. The intensity of the signal output is proportional to the concentration of the analyte. The signal is then amplified and processed by the electronic system.

Characteristics of a Biosensor

1. It ought to be extremely specific for the analyte.
2. The reaction used ought to be freelance of manageable factors like pH, temperature, stirring.
3. The response ought to be linear over a helpful vary of analyte concentrations.
4. The device ought to be small and bio-compatible.
5. The device ought to be low cost, small, simple to use and capable of recurrent use.

Calorimetric Biosensor

Many catalyst catalyzed reactions are exothermic, generating heat which can be used as a basis for measure the speed of reaction and, hence, the analyte concentration. The analyte answer is skillful and a little packed bed column containing immobilized enzyme; the temperature of the answer is set simply before entry of the answer into the column and even as it's effort the column exploitation separate thermistors. Analyte example is that the use of aldohexose enzyme for determination of aldohexose.

Potentiometric Biosensors

These biosensors use ion-selective electrodes to

convert the biological reaction into signal. several reactions generate or use H^+ that is detected and measured by the biosensor. carbamide

Acoustic Wave Biosensors

Acoustic sensors use electricity materials, generally quartz crystals, so as to get acoustic waves. Their surface is typically coated with antibodies that bind to the complementary substance gift within the sample answer. This ends up in increased mass that reduces their undulation frequency, this modification is employed to work out the quantity of substance gift within the sample answer.

Amperometric Biosensors

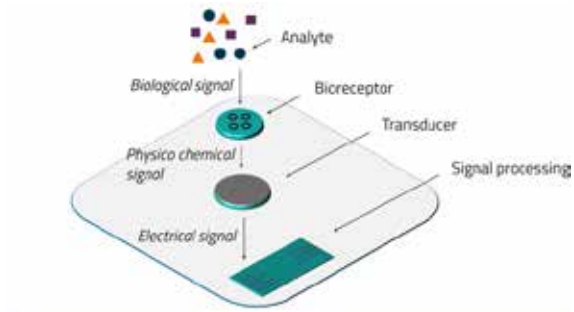
Amperometric biosensors perform by the assembly of a current once a possible is applied between two electrodes. The magnitude of current being proportional to the substrate concentration. These biosensors area unit} accustomed measure reaction reactions.

Optical Biosensors

These involve determinative changes in light-weight absorption between the reactants and product of a reaction, or measure the sunshine output by a light method. A most promising biosensor involving luminescence uses firefly catalyst luciferase for detection of bacterium in food or clinical samples.

Future Thrust of Biosensors

- Biosensor technology can Detect and doubtless Prevent—Illness
- Biosensor technology is on the verge of fixing however Diabetics Monitor their aldohexose levels
- Biosensor technology could put an end to Drunk Driving
- Bigger use of technology and microfluidics (LAB N A CHIP)
- Intelligent management of medication delivery
- Bigger use of home-based observation and treatment



Structure of a biosensor

20351

83. Plant Growth Regulators and their Mode of Action

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Introduction

Plant growth regulators are defined as the natural or synthetic biological substances which influence the overall growth and development of plants. There are five groups of plant growth regulators recognised *i.e.* auxins, gibberellins, cytokinin, ethylene and abscisic acid. Here, the mode of action of plant growth regulators are discussed in the context of the genes and transcription factors involved in this process.

Auxin

Auxins are a class of plant growth regulators (PGRs) having a main role in apical dominance in plants. Indole-3-acetic acid (IAA) is the basic and most abundant auxin present in plants. Auxins are chemical compounds with aromatic ring and a carboxylic acid group. Tryptophan is the precursor of auxin biosynthesis in plants. Auxin triggers the signal responses directly through stimulation or inhibition of the expression of genes. It activates different families of primary response genes like glutathione S-transferases, auxin homeostasis proteins like GH3 and the Aux/IAA repressors transcriptionally.

Auxin Signalling Pathway

ARE mediated transcription of auxin genes are initiated by auxin responsive factors (ARF). This transcription is then inhibited by binding of AUX/IAA protein complex. In absence of auxin, AUX/IAA protein complex binds and suppress transcriptional activity of ARFs. When auxin is present it forms a molecular complex between T1R1 protein and AUX/IAA, which results ubiquitone mediated proteolysis of AUX/IAA.

ARF are then free to bind to promoter and carry out transcription.

Cytokinin

Cytokinin are the PGRs generally derived from adenine. It promotes cell division in plants roots system and shoots system. The most common form of naturally occurring cytokinin is zeatin. Some examples of synthetic cytokinin are 6-benzyl amino purine, 6-phenyl amino purine. 5'-AMP is the precursor of cytokinin biosynthesis. Lowering the signals of cytokinin causes pleiotropic developmental changes and increasing endogenous cytokinin level causes expression of cytokinin biosynthesis gene isopentyl transferase (ipt) which reduces apical dominance and root development. A cytokinin signalling and response regulator protein is a plant protein that is associated with two-step cytokinin signalling and response regulation pathway.

Cytokinin Signalling Pathway

In the presence of cytokinin, cytokinin sensor kinases (CRE1/AHK4, AHK2, and AHK3) are activated and then auto-phosphorylates itself by transferring a phosphate from the kinase domain to receiver domain. This phosphate is then transferred to a histidine phosphotransfer protein (AHPs). Histidine phosphotransfer protein then phosphorylates a response regulator or transcription factors. Response regulators serve as positive or negative regulators of gene expression.

Gibberellins

Gibberellins (GAs) are a large family of tetracyclic diterpenoid plant growth substances. It is involved in seed germination and cell elongation. Ent-kaurene is a tetracyclic hydrocarbon which is the precursor of GAs. GA induced signal transduction involves 3 main types of transcriptional factors *i.e.* Gibberellin insensitive dwarf mutants (GAI), Gibberellin deficiency reversion mutants (RGA) and Spindly or slender mutants (SPY).

Gibberellin Signalling Pathway

GAI and RGA (DELLA repressors) both have conserved region for DELLA proteins. GAI and RGA act as repressors of those genes that lead to growth. SPY is also a repressor which act as upstream of GAI and RGA which play inhibitory role directly or by enhancing effect of GAI and RGA. In presence of GA these repressors are degraded, so transcription of genes occurs that lead stem elongation.

Ethylene

Ethylene is a PGR produced by plants which aids in ripening and aging process of plants. The amino acid methionine is precursor of ethylene. Ethylene after its biosynthesis is perceived by a family of receptors located in endoplasmic membrane, then ethylene signalling pathway starts. Signalling involves protein kinases, GTP binding proteins and transcription factors (EIN2, EIN3).

Ethylene Signalling Pathway

Ethylene signal perception and transduction is mediated by copper cofactor receptor. Then the receptors interact with protein kinases like CTR1. Binding of ethylene to receptors results in inactivation of both receptors and CTR1 which causes depression of positive regulatory molecule EIN2. It is then transmitted from EIN2 to EIN3/EIL1 resulting in accumulation of EIN3 factors in nucleus. There it induces transcription of ethylene regulated genes like ERF1, EBF1, 2, 3, and 4 resulting in ethylene gene expression.

Abscisic Acid (Aba)

Abscisic acid is a plant growth regulator which involves in developmental processes including seed and bud dormancy, control of organ size and stomatal closure. It is an inhibitory hormone in plants that help in adaptation to stress. Xanthoxin is an advanced biosynthetic precursor of ABA. ABA plays a critical role in response to various stress signals like drought, cold, and salinity. ABA induced gene expressions relies on presence of cis-acting elements called ABRE (ABA responsive element). These are regulated by various transcriptional factors like AREB, DREB2A, DREB2B, MYC/MYB, RD22BP1, and AtMyB2 which are responsible for the ABA gene expression in plants during the environmental stress.

Abscisic Acid Signalling Pathway

The ABA dependent stress signalling activates AREB which binds to ABRE element and induces stress responsive gene. The stress responsive gene (RD29B) encodes a LEA like protein (Late Embryogenesis Abundant Protein). Transcription factors like DREB2A, DREB2B, DRE cis-element and help in maintaining osmotic equilibrium in plant cells during stress. The MYC/MYB transcription factors bind its respective cis-elements MYBRS and MYCRS and helps in activation of RD22 gene. Overall, these transcription factors cross talk with each other for their maximal response to stress tolerance.

Conclusion

The plant growth regulators influence the growth and development processes in plants. The role play of these regulators could be individualistic or synergistic in plants which may conclude as a promoting or inhibiting response. Factors like temperature and light affect plant growth events (vernalisation) via plant growth regulators. So,

the study of the signalling behaviour of the plant growth regulators in plants is highly essential to understand the molecular processes operated in the plants.

References

Roberts, L. W., Gahan, P. B., and Aloni, R. 2012. Vascular differentiation and plant growth regulators. Springer science and Business media.

Minocha, S. C. 1987. Plant growth regulators and morphogenesis in cell and tissue culture of forest trees. In Cell and tissue culture in forestry. Springer, Dordrecht. pp. 50-66.

MICROBIOLOGY

19980

84. Antibiotic Resistance and Rationale to their use

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What is an antibiotic: A secondary metabolite produced by a microorganism naturally against another microorganism or made synthetically inhibiting the growth of microorganism. These may be bacteriostatic or bactericidal in nature.

Classification of Antibiotics:

1. Bacteriostatic: Antibiotics that not neccassarily kill the microorganisms but stop their growth and multiplication.
2. Bactericidal: Which kills the microorganism completely.
3. Broad Spectrum: Acts against a wide range of disease causing bacteria. Example: Cefixime, ciprofloxacin
4. Narrow Spectrum: act against a selected group of bacteria. Example: penicillin, amoxycillin

Antibiotic Resistance: The ability of a microorganism to resist the effects of an antibiotics to which it become sensitive. Antibiotics resistance is a mainly due to the overuse of antibiotics. Microorganisms that develop antimicrobial resistance are also known as as "superbugs".

Causes of Antimicrobial resistance:

- **Selective pressure:** When a microbes carry resistance genes and can replicates in the presence of an antibiotic.
- **Mutation:** Mutations in the microbes can help microbes survive exposure to antibiotics.
- **Gene transfer:** A microbe get genes from other microbe that makes the microbes drug resistant.
- **Inappropriate/ Over use:** Inappropriate use of antibiotics can make it resistant.
- **Inadequate diagnostics:** Sometimes broad spectrum antibiotics are used even when a specific antibiotics might be better .
- **Agriculture use:** Adding antibiotics to agricultural feed can promote drug resistance.

Example of Antibiotic Resistant Bacteria:

- Methicillin-resistant Staphylococcus aureus (MRSA)
- Vancomycin-resistant Enterococcus (VRE)
- Multi-drug-resistant Mycobacterium tuberculosis (MDR-TB)
- Carbapenem-resistant Enterobacteriaceae (CRE) gut bacteria

Pecautions for extending the useful life of antimicrobial drugs:

- Optimal use of all antimicrobial drugs
- Selective removal, control or restriction of classes of antimicrobial agents
- Use of antimicrobial drugs in rotation or cyclic patterns.
- Use of combination antibacterial therapy to slow the emergency of resistance
- Evaluation of routes of resistance
- Implementation of global changes

References

O'Malley M and Dupre´ J .2007. Size doesn't matter: Towards a more inclusive philosophy of biology. Biology & Philosophy. 155–191.

Landecker, H. 2015. Antibiotic Resistance and the Biology of History. Body and Society.1-34.

Yim G, Wang HH and Davies J. 2007. Antibiotics as signalling molecules. Philosophical Transactions of the Royal Society B: Biological Sciences. 1195–1200.

20241

85. A Short Note on Hantavirus

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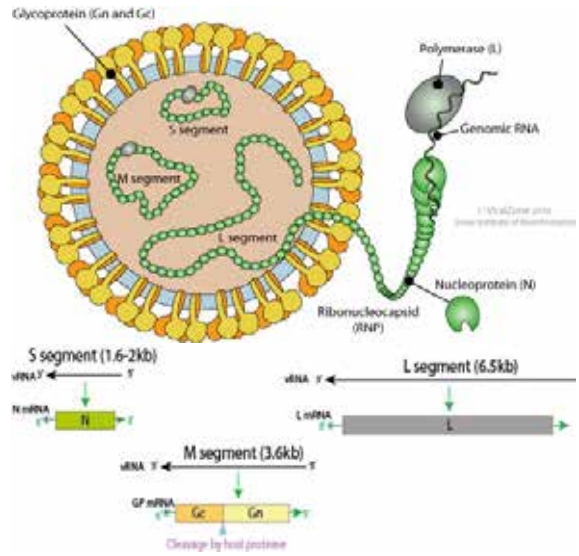
Hantavirus

Hantavirus was first diagnosed in an endemic in 1993 in the "Four Corners" area of the southwestern U.S. And determined to be transmitted to people through rodent urine, feces, saliva, and by airborne debris containing these items. The 2012 outbreak at Yosemite National Park turned into because of hantavirus switch to humans by means of deer mice. Hantavirus are carried via rodents and can cause severe respiratory infections termed hantavirus pulmonary syndrome (HPS) and hemorrhagic fever with renal syndrome (HFRS).

Genome Structure and Replication of Hantavirus

The single-stranded, negative-sense, RNA genome of hantavirus is tri-segmented into small, medium and large (S, M, and L) segments. L section is among 6.8 and 12 kb, M section between 3.2 and 4.9 kb and S phase among 1 and 3 kb. The segments, respectively, encode three structural proteins: nucleocapsid (N) protein, glycoproteins Gn and Gc and an RNA-established RNA-polymerase. Some hantaviruses additionally encode a NSs protein on their S segment. The genome segments, encapsidated with the aid of the N protein to shape ribonucleoproteins, are enclosed inside a lipid envelope that is embellished via spikes composed of Gn and Gc.

The virus attaches to host receptors though Gn-Gc glycoprotein dimer, and is endocytosed into vesicles within the host cell. Endocytosis can arise via clathrin-mediated endocytosis, caveolin-mediated endocytosis or clathrin- and caveolin-unbiased endocytosis. The fusion of virus membrane with the vesicle membrane results in the launch of ribo-nucleocapsid segments inside the cytoplasm. The RNA dependent RNA polymerase (RdRp) complex initiates transcription through binding to the leader collection in 3′ of the genomic negative-strand RNA. Viral mRNAs are capped inside the cytoplasm. Replication presumably starts when enough nucleoprotein is gift to encapsidate neo-synthetized antigenomes and genomes. The ribo-nucleocapsids buds at the Golgi apparatus, liberating the virion by using exocytosis.



(Source -https://viralzone.expasy.org/213?outline=all_by_species)

FIGURE 1: Structure and genome organization of Hantavirus

Pathogenesis of Hanta Virus

Humans are infected by means of hantavirus particularly thru inhalation of aerosolized virus-infected rodent excreta and the higher the quantity of inflamed rodents, the higher the chance of human infection. Hantaviruses motive two probably deadly diseases, HPS and HFRS, and both illnesses bring about defects in vascular permeability and platelet function. Human beta 3 integrins confer cellular susceptibility to HPS- and HFRS-inflicting hantaviruses, a truth at once linking platelets, endothelial cells and hantavirus sicknesses to the use of mobile receptors that keep capillary integrity and regulate platelet function. The incubation duration of hantavirus is enormously long: 2-4 weeks. The very first barrier that the virus encounters when coming into the frame is the mucus gel that covers respiratory epithelial cells. In the decrease respiration tract, trapped microbes are removed by way of the ciliated cells that always pass the mucus with their cilia away from the lungs to the throat. When the virus has surpassed the mucus gel, it encounters yet some other barrier the respiratory epithelium which has

tight junction integrity and a particle-impermeable barrier and affects cells. Despite being infected, these cells display no cytopathic effect (CPE) and the epithelial tight junction integrity is intact. The virus is able to infect thru both the apical membrane and the basolateral membrane and subsequently, virus particles are secreted bidirectionally. Once the breathing epithelium has been traversed, the virus spreads to the lung endothelium and greater distant locations in the body.

Symptoms of Hps And Hfrs

Early symptoms of HPS include fatigue, fever, muscle aches, especially within the thighs, hips, and back, headaches, chills, dizziness, nausea, vomiting, diarrhea or belly pain. In the overdue level of contamination with a hantavirus subtype, patients experience lung congestion, fluid accumulation within the lungs, and shortness of breath. Symptoms of HFRS usually broaden within 1 to two weeks after exposure to infectious agents, but in uncommon cases, they will take up to eight weeks to increase. Initial signs begin unexpectedly and encompass excessive headaches, back and stomach pain, fever, chills, nausea, and blurred vision. Individuals may have flushing of the face, inflammation or redness of the eyes, or a rash. Later symptoms can include low blood pressure, acute shock, vascular leakage, and acute kidney failure, which can reason extreme fluid overload. The severity of the disorder varies relying upon the virus causing the contamination.

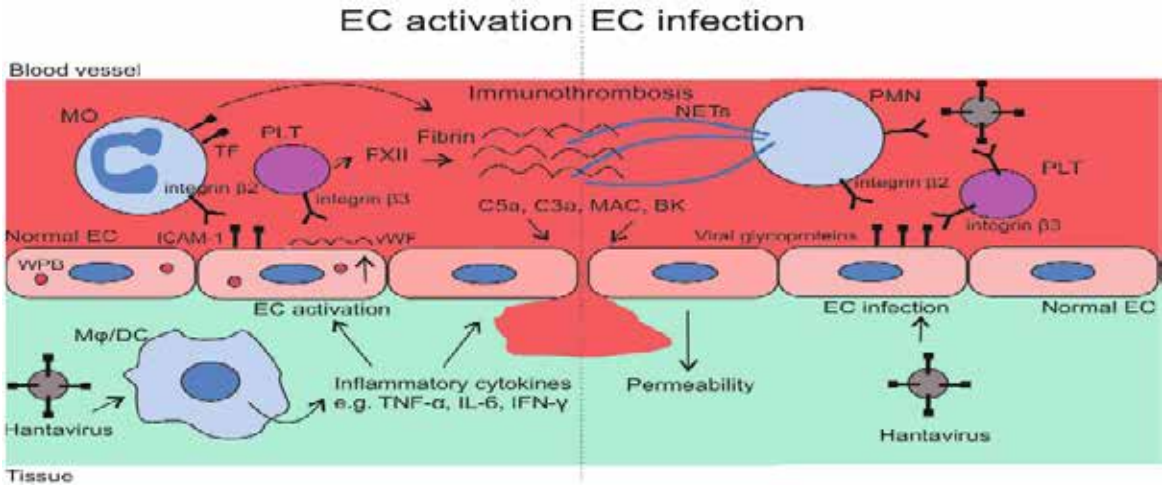


FIGURE 2: Pathogenesis of Hanta Virus (Source: https://doi.org/10.3389/fmicb.2014.00727)

Diagnosis

The detection of anti-hantavirus IgM and/or IgG antibodies in serum is the most common approach used for laboratory prognosis of HCPS and HFRS. Diagnosis is completed via indirect immunofluorescence assay (IFA) the use of hantavirus-inflamed cells constant as an antigen in glass plates. Most of the hantavirus antigens utilized in serologic exams have been obtained by means of using rDNA methods. Immunoblot and neutralization exams have additionally been used for the serologic prognosis of hantavirus infections. The hantavirus genome may be swiftly detected by means of reverse transcription (RT)-PCR in medical samples, including blood, serum or organ fragments, following on from the primary day after the onset of illness. The real-time modality of RT-PCR is a fast and sensitive tool for the laboratory prognosis of hantavirus infection which allows determination of the virus load in clinical samples. At present, the combination of a serologic test, including the IgM ELISA with the RT-PCR, are enormously touchy and desirable method for the laboratory diagnosis of hantavirus contamination.

Reference

Jonsson, C. B., Figueiredo, L. T. M., & Vapalahti, O. (2010). A global perspective on hantavirus ecology, epidemiology, and disease. *Clinical microbiology reviews*, *23*(2), 412-441.

Hepojoki, J., Vaheri, A., & Strandin, T. (2014). The fundamental role of endothelial cells in hantavirus pathogenesis. *Frontiers in microbiology*, *5*, 727.

NANOTECHNOLOGY

20358

86. Nanoherbicides: A Smart Delivery System Over Conventional Herbicides

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Nanotechnology is science of manipulating materials at nano-scale. It has many applications in all stages of production, protection, processing, storing, packaging and transport of agricultural products. Weeds are considered as the important hazardous factor in agriculture, as they reduce the yield up to a great extent of 15 to 30 per cent. Hence, weeds should be managed below the threshold level of economic loss. In this regard an extensive use of herbicides is noticed at present day agriculture when compared to other weed management practices available like cultural, mechanical and biological methods. However, intensive use of the herbicides and other classes of chemical products in agricultural practices has resulted in serious environmental issues along with increased level of herbicide residues in natural water bodies, soil and food chain. On the other hand, repeated over use of same herbicides resulted in development of herbicide resistant weeds and creating concern over the use of conventional herbicides. Across the globe, nearly 249 herbicide resistant weed biotypes have been identified so far over 47 countries and this number constantly increasing on an annual basis resulting in development of new resistant weeds. At present, use of herbicides at recommended dose, rotation of herbicides and use of herbicide mixtures are the strategies employed to reduce herbicide resistance development but they are not upto the mark. Hence effective management strategies are required to combat the herbicide resistant development by weeds. In this context, nanotechnology offers a way for averting the overuse of herbicide and promise increased crop productivity with safe delivery system. At present situation, nanoherbicides are one of the newly evolved strategies for combating the problems of conventional herbicides as they address the perennial weed problems and helps to exhaust weed seed bank along with reduced environmental issues.

Nanoherbicides are formulations made by exploiting the nanotechnology for effective delivery of chemical with the help of nanosized preparations or nanomaterials-based herbicide formulations. The size of nanoherbicide is 2,000 to 50,000 times smaller than the size of particles used in the preparation of conventional herbicides. In nanoherbicides, nanostructured formulations require less amount of herbicide and perform action through controlled release mechanism as they comprise polymeric and metallic nanoparticles.

Advantages of Nanoherbicides over Conventional Herbicides

- Reduced amount of chemical substance requirement for weed management
- Enhanced absorption of chemical substance into plant tissue
- Nanomaterials improve the efficacy of herbicide
- Nanomaterials enhance the solubility chemical substance and reduce the toxicity in comparison to conventional herbicides
- Nanoherbicides help to eliminate the weeds before resistance development because of higher penetration efficiency
- Nanocarriers provide short and long residual effect of herbicides based on the need and avoids the lethal dose at which weeds could develop herbicide resistance
- Controlled release from nano formulations due to smart delivery mechanism
- Reduced environmental pollution
- The nanoparticle systems for herbicide delivery are mostly composed of polymeric substances and are biodegradable with non-toxic metabolites

In addition to above advantages, nanoherbicides have some disadvantages like human health issues, environmental pollution due to possibility of nanoparticles accumulation in soil, water and plant and also cost involved in production of nanoparticles plays a crucial role in its large-scale adoption in agriculture in near future. Hence the development of nanoherbicides by taking care of above-mentioned disadvantages will helps to evolve the sustainable and ecofriendly agricultural technology as development of the nanoherbicides is still in nascent stage.

ENVIRONMENTAL SCIENCES

87. 20195Concepts of Ecology

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Definitions

The science of relationship of organisms to their environment.

1. **Haeckel (1907):** Domestic side of organic life.
2. **Simpson (1964):** Given an existing population structure and an existing ecological situation, and given the genetic variation of the population as it moves through time, the action of selection seems to be fully deterministic.

An individual is the basic and primary unit of ecology.

Niche

A set of biotic and abiotic conditions in which a species is able to persist and maintain stable population.

Population

A group of potentially interbreeding individuals at a given locality. Mayr (1963).

Species

Group of populations that actually or potentially interbreed with each other constitutes a species.

Speciation

is the method by which evolution advances. (Hamilton, 1967).

Community

Co-existing interdependent population, and the ecosystem.

OR

Community and its physical environment.

Biomes

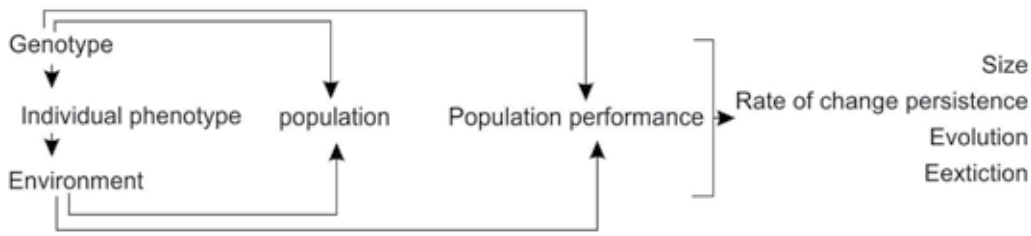
Regional ecosystem types such as grassland, desert, deciduous forest etc,.

Biosphere

Biological system that includes all of earth's living organisms interacting with the physical environment. (Odum, 1971)

Life System

Part of an ecosystem that determines the existence, abundance and evolution of a particular population.



The phenotype in a population are influenced by two constantly changing interacting process- the genotype and the environment.

Adaptation

Any quality of an organism, population or species that increases its chances of living viable progeny.

Fitness

The ability of an individual or a population to leave a viable progeny in relation to the ability of others.

Classification Based on Habitat

HABITAT: A place where an organism lives.

Eg: Marine ecology, fresh water ecology etc,

Classification Based on Level of Organisation

1. **Autecology**: Individual organism in relation to its environment.

   Eg: Geographic distribution of insects, insect

resurgence etc,

2. **Synecology**: Group of organisms in relation to environment.

Eg: population ecology, community ecology, biomes, ecosystem ecology etc,

Biocoenosis/Biogensis
GALA hypothesis
Homeostasis
Plato's Natural balance vs Ecological dynamics.

Biological Organisation

Is the hierarchy of complex biological structures and systems that define life using a reductionist approach.

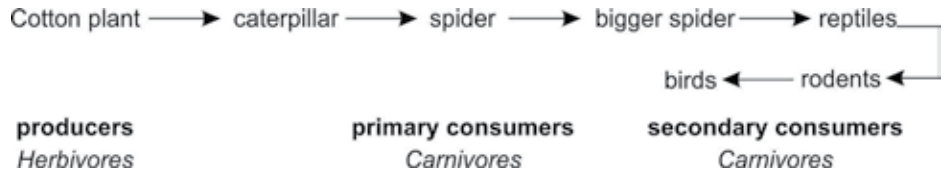
The traditional method of describing biological organisation is called ecological organisation or hierarchial ecology, which describes biological organisation from atoms to biosphere. Each level in the hierarchy represents an increase in organizational complexity with in each object composed primarily of previous level basic unit.

Insects in Relation to Environment

BIOTIC FACTORS	ABIOTC FACTORS
1.Host plant/ food	1. Temperature
2. Natural enemies	2. Moistur/RH
a. Parasites	3. Light
b. Predators	4. Wind/Air currents
c. Pathogens	5. Water currents
	6. Edaphic factors
	7. Electrical factors
	8. Physical factors

Host Plant/ Food

- 1st trophic level-producers or autotrophic
- 2nd trophic level-primary consumers, heterotrophic herbivores and micro-organisms
- 3rd trophic level-secondary consumers, heterotrophic parasites, predators, saprophytes.



20306

88. IUCN Red List: At a Glance

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Introduction

The world most environmental issue is changing of climatic condition and its major threat to biodiversity loss. We lose a lot of plant and animal species day by day. Major reason is anthropogenic activities affected the habitat niche and significant numbers going to extinct. The international organization of IUCN (International Union for Conservation of Nature and Natural resource) involved in growing awareness and listed endangered spices through geographical wise. IUCN released the RED DATA BOOK for every year and mention the extinct, endangered and vulnerable species. RED means symbolic of danger that the plant and animal species presently experienced throughout the world. RED DATA BOOK of India involved to the conserve of plant and animals which are endemic to the Indian region. The Ministry of Environment Forest and Climate Change give the guidance to Botanical Survey of India (BSI) and Zoological Survey of India (ZSI) the conducted survey.

Red Data Book

The RED DATA BOOK was first issued in the year of 1966 under IUCN's special survival service commission as a leader for formulation and management of species listed. In this book has colour page (code) information sheets, which are arranged according to the extinction to vulnerable species. Red colour pages expressed to species that are endangered, black colour pages which are conform extinct, pink colour pages include the critically endangered species, green for formerly endangered, amber colour expressed to species considered to be vulnerable and grey colour pages to species enough information is not available.

(Fig.1) Red data book helps to find the animals, birds and their conservation status, evaluation the population (particular species) and use to frame the conservation measures.

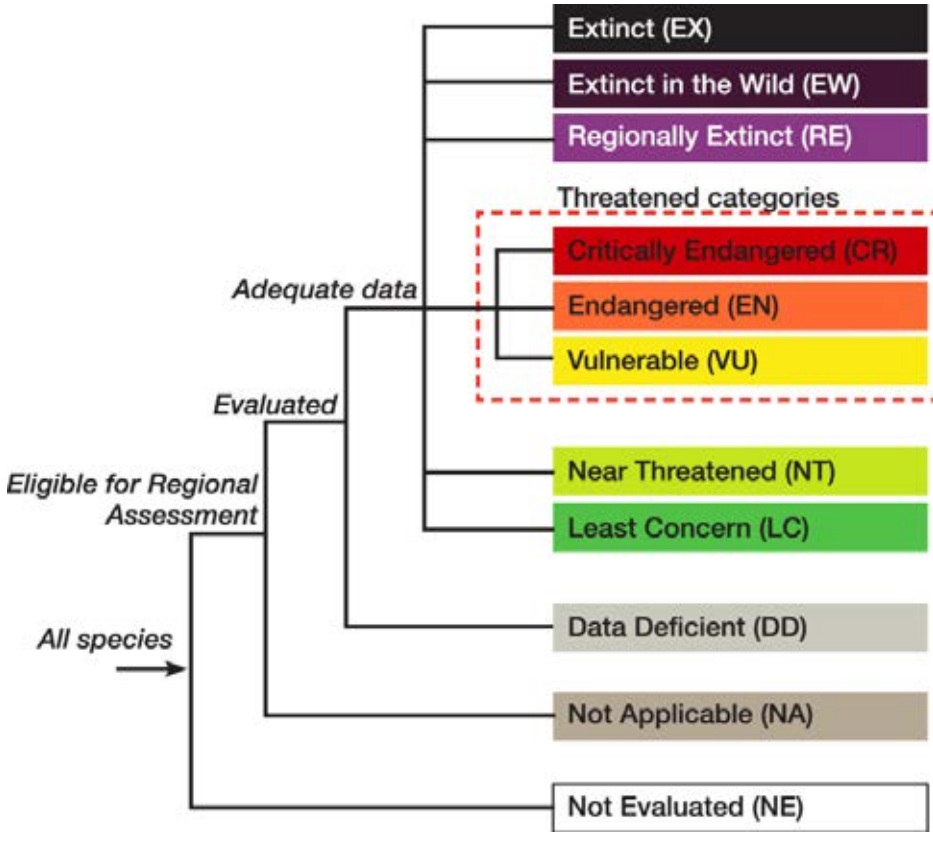

FIG.1. Groups in IUCN Red list

IUCN Classification

The main aim and working in the field conservation of nature and sustainable manage of natural recourses. The international organisation of IUCN classifies the species into nine categories.

TABLE 1. Nine categories of species defined by IUCN

Category	Definition
Extinct	No known individuals remaining
Extinct in the wild	known only to survive in captivity, or as a naturalized population
Critically Endangered	Extremely high risk of extinction in the wild
Endangered	High risk of extinction in the wild
Vulnerable	High risk of endangered in the wild
Near Threatened	Likely to become endangered in the near future
Least Concern	Lower risk
Data Deficient	Not enough data to assess its risk of extinction
Not Evaluated	Has not yet been evaluated against the criteria

TABLE 2. IUCN RED LIST species in India

Critically endangered Mammals	Endangered mammals
Himalaya Brown/Red Bear	Tigers
Pygmy Hog	Asiatic Lion
Andaman White Toothed	Red Panda
Shrew	Indian Wild Dog
Kondana Rat	Brow Antlered Deer
Large Rock Rat/ Elvira Rat	Golden Langur
Namdapha Flying Squirrel	Himalayan Musk Deer
Malabar Civet	Assam Rabbit
Sumatran Rhinocerous	Hog Deer
Kashmir stag/Hangul	Lion-tailed Macaque
	Nilgiri tahr
	Kharai Camel

Conclusion

The international organization (NGO) for compiling and publishing the Red List. Red Data Book describes base for documenting endangered and rare species of flora and fauna as well some local species that exist within the state or country. In this book support the full record of animals, plants, other species but it has lack of information about the microorganisms. Hence, to support

the conservation programme, this assesses the conservation the endangered and rare species worldwide.

Reference

Sharma, P D. (2017). "*Ecology and environment*" (13th edition). Rastogi Publications

POLLUTION AND MANAGEMENT

20258

89. Genetically Engineered Microorganisms on Pollution Management

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Introduction

A genetically engineered microorganism is a microorganism, in which the genetic engineering attempts have been made to improve its biodegradation potential. During the early 1980s, the cloning and characterization of genes responsible for coding catabolic enzymes for toxic chemical compounds were started. Nowadays, the need for genetic engineering in the field of bioremediation has been realized by many molecular biologists and microbiologists. Genetically Engineered Microorganisms (GEMs) have shown potential for bioremediation applications in soil, groundwater, and activated sludge environments, exhibiting enhanced degradative capabilities encompassing a wide range of chemical contaminants. Application of genetically engineered microorganisms (GEMs) for use in bioremediation has seen little development over the past decade.

Features of Genetically Engineered Microorganisms

There are four main approaches for developing the genetically engineered microbes, which include (i) Alteration of enzyme specificity and affinity (ii) Gene construction and regulation pathways (iii) Process development, monitoring and controlling of bioremediation (iv) Application of sensor-based bio affinity bioreporter for reducing toxicity, sensing chemicals and analyzing end points. Hence, the use of GMOs clearly proved its biodegradation capability of environmental contaminants (Pandey *et al.*, 2005).

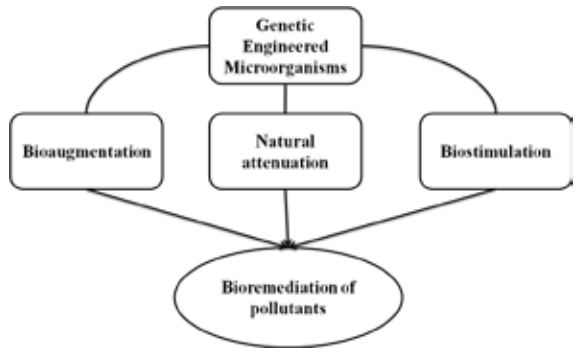

FIG. 1. Bioremediation of pollutants utilizing GEMs

Application in Pollution Management

Organic pollutants removal by GMOs

The strain *Comamonas testosteroni* VP44 naturally possess the genes to degrade toxic chlorinated biphenyls into less toxic ortho-and para-chlorobenzoic acids. Degradation pathway of DNT (2,4-dinitrotoluene) from *Burkholderia* sp. was engineered into *Pseudomonas fluorescens* ATCC 17400. As a result, the recombinant strain is superior in degradation of DNT at cold temperatures and also non-pathogenic to some plants. A novel partial reductive pathway was discovered by cloning the CNB-1 genes from *Comamonas* sp. into *E. coli* to detoxify 4-chloronitrobenzene and nitrobenzene. The recombinant strain efficiently desulphurized the dibenzothiophene compared with native *R. Erythropolis* IGTS8 without affecting the active principles of fuel content. Cloning of organic toxic degrading enzyme gene into radiation-resistant organisms for example, engineering a high-radiation-resistant strain *Deinococcus radiodurans* by cloning with toluene

dioxygenase gene obtained from *Pseudomonas putida* F1 (Wasilkowski *et al*., 2012).

Heavy metal removal by GMOs

The heavy metal removal efficiency of genetically engineered organism has been proved with *Alcaligenes eutrophys* AE104 for the removal of chromium in wastewater effluent from industries. Similarly, photosynthetic recombinant bacterium, *Rhodopseudomonas palustris*, proved the transport of metallothionein for mercury removal.

Mercury is one of the most hazardous heavy metal in the ecosystem. Expression of bacterial *mer* genes in mercury resistant bacteria is associated with the biodegradation of mercury. The *mer* A gene from *E. coli* BL308 was cloned and expressed in a well-studied radiation-resistant organism, *Deinococcus radiodurans* to remediate the mercury-contaminated site. Arsenic in its oxidized forms is more toxic. It has been reported that a tenfold increase in release of the volatile methylated arsenic gas by cloning *ars*M gene from *Sphingomonas desiccabilis* and *Bacillus idriensis* in *E. coli* compared with indigenous microbial flora. The genes encoding bacterial metallothioneins (*smt* A and *smt* AB) express the system to resist uptake and accumulate the lead in the chromosomal and extrachromosomal genetic material within the cell (Chen *et al*., 2013).

Factors Influencing Genetically Engineered Microorganisms

The success of genetically engineered microorganisms depends on factors such as survivability, stability under field conditions and rate of gene transfer from engineered genotypes to native microbes. There are Survival of genetically modified microorganisms (GEMs) and Transmission of genetically engineered microorganism into native organisms

Conclusion

The efficiency of bioremediation can be improved by the use of genetic engineering techniques has become a productive way to develop the recombinant microorganisms to actively degrade specific contaminants. The main target involves the biodegradation of aromatic compounds through manipulating with genes, modification of pathway/alteration or construction of host gene sequences. The survivability and stability of GEMs are the critical issues in the field of bioremediation. There is a great promise by researchers that execution of the GEMs-based bioremediation of contaminant site will be harmless to biological system. But still, we are at an anxious junction where, on the one hand, we find the opportunities to change the genetic construction by recombinant DNA technology and make use of those modified organisms. The biosafety regulatory frameworks and the application of precautionary principles contribute the platform for the future development and application of genetically modified organism in the field of bioremediation.

References

Chen J, Qin J, Zhu Y-G, de Lorenzo V, Rosen BP (2013) Engineering the soil bacterium *Pseudomonas putida* for arsenic methylation. Appl Environ Microbiol 79:4493–4495

Wasilkowski D, Swedziol Z, Mrozi A (2012) The applicability of genetically modified microorganisms in bioremediation of contaminated environments. Chemik 66:817–826

Pandey G, Paul D, Jain RK (2005) Conceptualizing "suicidal genetically engineered microorganisms" for bioremediation applications. Biochem Biophys Res Commun 327:637–639

FOODS AND NUTRITION

20234

90. Alcohol during Pregnancy: Impact on CNS Development of Child

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Alcohol consumption in today's era, as we hear, is a way of taking a short pause from long monotonous work hours, with friends and family; and women are no exception. Surveys reveal that today, since almost all the social events are held together by a drink, drinking among women is just like a norm

and not a problem. Being self-dependent with high aspirations and affluence, they are exposed to an altogether different lifestyle and changing gender roles, hence women no longer have to care for social and cultural barriers.

But alcohol consumption during pregnancy is not merely a culturally frowned upon issue. It has been proven to be fatal to the unborn child. The central nervous system of the fetus is highly sensitive to alcohol throughout pregnancy. The extent of exposure of fetus to alcohol determines the severity of abnormalities within the fetal brain and future behavioral, neurological and psychological defects.

It was in the year 1973 that a pattern of birth defects and delays in development was figured out and was termed as fetal alcohol syndrome (FAS), a syndrome of facial dysmorphology, growth impairment and central nervous system dysfunction in the children of women who abused alcohol during pregnancy. A spectrum of abnormalities in the child occurring due to alcohol exposure during pregnancy is referred to as fetal alcohol spectrum disorders (FASD). Some general symptoms include facial abnormalities (small eye openings or flat face) which become noticeable by 2-3 years of age, pre- and post-natal growth retardation and cognitive and behavioral problems. Heavy alcohol consumption during pregnancy might also result in miscarriage, stillbirth or premature delivery.

It has been estimated through a research performed by WHO that one out of 67 women who consume alcohol during pregnancy would give birth to a child with FAS, which can be interpreted as about 1,19,000 FAS children born globally every year. Also, it was found that the five countries with highest prevalence of prenatal alcohol consumption were Ireland (about 60%), Belarus (47%), Denmark (46%), the United Kingdom and Northern Ireland (41%) and the Russian Federation (37%).

The two stages of prenatal development are the embryonic stage (first eight weeks of development after fertilization which are more sensitive to pre-natal alcoholic damage) and the fetal stage (development occurring in the remaining gestation period). The embryonic stage is the period when body structure and organ systems are determined. If a woman consumes alcohol at this stage, it might result in severe congenital defects and malformations. Between third to sixth weeks after fertilization, when neurulation (transformation of neural plate into neural tube) occurs, the cranial neural crest cells are vulnerable to alcohol-induced damages. These cells along with ectoderm differentiate into facial features. This damage might lead to minor midline facial abnormalities.

The anterior portion of neural tube forms neuroectoderm (first step in development of central nervous system). From third month to third trimester, the progenitor cells (radial glia) which guide the formation and migration of neurons during CNS development become vulnerable to alcohol. Such damage to CNS might lead to morphological abnormalities and an overall reduction in white matter within the brain. The ocular development which starts in the third week of gestation and continues up to fifth week is also affected due to consumption of alcohol during pregnancy and retina becomes sensitive to alcohol. Congenital defects like microphthalmia (abnormally small eyeballs) and optic nerve hypoplasia (underdevelopment of optic nerves) may develop in such cases.

Damage to the brain continues in sixth and seventh weeks. Corpus callosum (a structure meant for communication between the left and right hemispheres of brain) becomes vulnerable to alcohol. At the end of eighth week, the embryo becomes a fetus and fetal stage begins. Since most of the organs and organ systems have been formed during embryo stage, much lesser developmental defects might occur in fetal stage. During this stage the most vulnerable part of CNS development is the formation of cerebellum. Cerebellum is developed later in the 24th week of gestation and alcohol might affect the cellular migration and synaptogenesis. The fetus begins to develop self-regulation and tries to cope with environmental damage by the third trimester.

A number of complications are faced by a FAS child after birth. There may be low birth weight, hearing loss, speech defects, facial abnormalities and microcephaly. Dysphagia is commonly seen in such children due to delayed oral motor development which means that they have difficulty in sucking and swallowing.

After birth the children prenatally exposed to alcohol show various problems related to language and memory. In a research conducted by Mattson and group in 1996, it was observed that children with FAS aged 5 to 16 could learn lesser words as compared to their counterparts who did not have FAS. Children born to mothers who drank heavily during pregnancy are unable to perform the tasks involving learning spatial relationships among objects. In another experiment done by Uecker and Nadel in 1996, it was seen that children with FAS had greater difficulty in replacing the objects to their original positions on the table. Hence, they concluded that children with FAS were unable to perform delayed object recall and had a general spatial memory deficit. FAS children have been generally confused with those suffering from attention deficit hyperactivity

disorder (ADHD). Researchers have differentiated between both the disorders and have observed that while ADHD children have difficulty with focusing and maintaining attention over time, FAS children face problems with encoding and shifting attention from one task to another. Besides, children suffering from FAS might face difficulty in performing executive functions which means that they are unable to perform the activities which involve abstract thinking, in a proper way. As an example, a child with FAS would face difficulty in naming animals, then changing to naming kitchen equipments and then back to naming animals. They are also seen to have poor reasoning and judgment skills.

The crux of the matter is that there is

- no known safe amount,
- no known safe time and
- no safe type of alcohol to be consumed during pregnancy.

Motherhood is a blessing that comes along with responsibilities and challenges; therefore, the partner and family must be there to help and support the mother to-be during pregnancy. It must be borne in mind that abstaining from alcohol is the only way to save your child from a life of distress and incapabilities, which further leads to a low self-esteem throughout lifetime. As it is very beautifully said by Linda Wooten,

"Being a mother is learning about strengths you didn't know you had and dealing with fears you never knew existed".

Keywords: Alcohol, Fetus, Fetal Alcohol Syndrome, CNS, Developmental Defects

Abbreviations: CNS- Central Nervous System, FAS- Fetal Alcohol Syndrome, FASD- Fetal Alcohol Spectrum Disorder, ADHD- Attention Deficit Hyperactivity Disorder

References

Charness, M.E., Riley, E.P. and Sowell, E.R. (2016). Drinking During Pregnancy and the Developing Brain: Is Any Amount Safe? *Trends in Cognitive Sciences*, 20(2): 80-82.

Hepper, P.G., Dornan, J.C. and Lynch, C. (2012). Fetal brain function in response to maternal alcohol consumption: Early evidence of damage. *Alcoholism: Clinical and Experimental Research*, 36(12): 2168-75.

Neil, E.O. (2010). Effects of Prenatal Alcohol Exposure on Central Nervous System Development. Retrieved on 25 May 2020.

Peadon, E. and Eliott, E.J. (2010). Distinguishing between attention-deficit hyperactivity and fetal alcohol spectrum disorders in children: clinical guidelines. *Neuropsychiatric Disease and Treatment*, 6: 509–515.

FISHERIES

20293

91. Sustainable Seafood without the Catch

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When the sustainability of our food system is in serious question & new modes of doing are now required (Schneider *et al.*, 2019) for a liveable post-Anthropocene (time scale of human mastery of the planet). Report by the EAT-Lancet Commission as part of a report released in The Lancet (a peer reviewed medical journal) on 16 January 2019 highlights the need for a radical transformation of the global food system to deliver both environmental sustainability and improved human health. It projects a baseline for food consumption to 2050 based on expected population growth and current trends in food consumption.

To cater the increasing demand, we are squeezing our marine resources. It has been estimated that due to over fishing of marine resources have lowered ocean biomass content by up to 80% (Myers and Worm, 2003). This activity, along with effects of global warming on tropical oceans and its impact on rainfall threatens to decimate wild fish populations (Funk and Brown, 2009). While some herald the rise of aquaculture as an ecological and economic boon as this industry is now the fastest growing food-producing industry in the world (Tidwell and Allan, 2001). However, apart from direct consumption, ever increasing demand of fish meal & fish oil, by-catch killing of fish are posing great threat to aquaculture. Others feel that its benefits have been over projected and that it does not fundamentally solve current strains on wild fish populations. Marine ecosystems may only sustain current and increased per capita consumption rates through 2050 if effective fisheries management measures are implemented and some significant technological adaptations are developed (Merino *et al.*, 2012).

Food production from the oceans carries the risk of ecological damage, cell-based seafood will provide a unique opportunity to transform the sustainability landscape. Cell based sea food is a nascent technology that allows fish flesh and other products to be cultured from cells in a bioreactor rather than harvested from livestock on a farm. It is a revolutionary technology that presents opportunities to decrease environmental footprint. This sustainable approach for food production will satisfy changing human needs, conserve natural.

The future possibilities for cellular aquaculture may sound big but are incredibly exciting. We can define cell based or cellular aquaculture as the production of aquaculture products from cell cultures rather than from whole animals. It means the production of genuine fish & other aquatic animal products (crabs, shrimp, oyster etc) without requiring animal breeding, rearing, and slaughter: in other words, farming cells or proteins directly rather than obtaining them from entire animals. The concept lies in fish cell and tissue culture to address challenges to orthodox industrial aquaculture systems and marine capture. It is to be noted that cell-based aqua products are quite different from genetically modified food. These are aptly called as cell-based meat, clean meat, lab-grown meat or *in vitro* meat.

Till date there are nearly a dozen startup companies are going the cell-to-flesh route with clandestine technique in the laboratories. Among these BlueNalu of San Diego, USA and Finless Foods of *Emeryville, California, USA,* Mosa Meat *(*Netherland) are racing to produce seafood at large scale directly from fish cells. BlueNalu's mission is to provide consumers with great tasting, healthy, safe and trusted cell-based seafood products that will also support the sustainability and diversity of our ocean. This alternative production will deliver to the consumer a product that tastes and performs identically to the fish product it seeks to substitute. Further cellular aquaculture will provide clean meat, genuine meat grown by cultivating fish muscle cells.

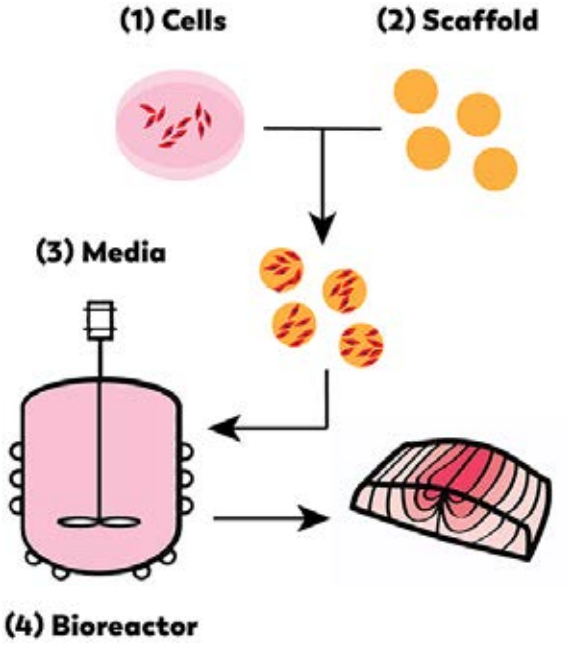
In 1931 Winston Churchill, former British prime minister & prominent politician, published an article in *Strand Magazine* where he imagined the world "Fifty Years Hence." In that write up he envisioned lab-grown meat & wrote: "...We shall escape the absurdity of growing a whole chicken in order to eat the breast or wing, by growing these parts separately under a suitable medium." Researchers *have proved* that our *imagination* can turn into *reality*. The first lab-grown meat product, a hamburger, was fried up in 2013, eighty-two years later than Churchill's prediction. The cost of producing lab-grown meat products is still extremely high ($9,000 per pound for Memphis Meats's chicken). Uma Valeti and Nicholas Genovese founded San Francisco based Memphis Meats in 2015. Valeti grew up in Vijayawada, India, where his father was a veterinarian and his mother taught physics. When he was 12, he attended a neighbor's birthday party & wandered around to the back of the house, where cooks were decapitating and gutting animal. While processing the meat in such an *unhygienic manner* he was contemplating "It was birthday or death day,". "It didn't make sense." Later Valeti moved to the U.S. for his medical residency. But in time, he found himself increasingly disturbed by food-borne illness by the contamination that happens in slaughter houses when animal faeces get mixed in with meat." He was then contemplating "I thought, there has to be a better way."

Fish Without the Fish?

High-tech meat alternatives are grabbing a lot of catchy headlines these days- 'Seafood without the sea' or 'Eating for the post-Anthropocene: alternative proteins' or 'Fish without the fish' or 'Finless fish' or 'lab grown fish' or 'Cellular aquaculture' or 'Sustainable seafood without the catch' & so on.

Few companies are progressing fast to bring to market what's known as cell-based fish or seafood --- that is, seafood grown from cells in a lab, not harvested from the oceans unlike today's wild-caught or farmed fish options. Finless Foods of Emeryville, California are using cellular biotechnology to grow fish (also other seafood) in bioreactors. They're doing similar work to Memphis Meats or JUST Foods, but are focused on fish instead of meat. Their first product will be very tasteful blue fin tuna, a species which is threatened with overfishing. They plan to bring it to market very soon. BlueNalu's version of seafood will have no head, no tail, no bones, no blood. It's finfish, just without the swimming and breathing part. It's seafood without the sea. Globally, there are roughly two dozen companies working on growing animal meat from cells, but most of them are looking at traditional livestock meats, like beef, chicken and lamb. Only six are focused on cell-based seafood, and three of them are based in California. All are likely five to ten years away from having actual product on the market. Lou *Cooperhouse*, President & CEO at *BlueNalu* says that his company does not rely on fetal bovine serum to feed fish cells. Cell-based seafood is free from potential contaminants that can be found in its ocean-caught counterparts — like mercury, toxins, pathogens and parasites, and even "micro-particles of plastics," as the company's website has projected. Likewise, Finless Foods' website boasts that its product will require "no commercial fishing

from our precious oceans. No fish farming. No contaminants."



Cooperhouse's partner Chris Somogyi, is confident BlueNalu is not using any genetic modification & not introducing new molecules into the diet.

The Technology in Brief

Cell-based seafood production will require the appropriate: (1) cell line(s), (2) compatible scaffold, (3) medium, and (4) bioreactor (Edelman *et al.*, 2005).

Cells

It all starts with a cell. We focus on identifying and selecting specific types of cells like mainly skeletal muscles, fat and connective tissues such as myoplasts which are able to self-renew and grow to become meat. They are multipotent cells, capable of trans-differentiation, and therefore need to be re-harvested from time to time

Feeding the Cells

You are what you eat, and so are cells. We unpack food into the most essential micronutrients needed for our cells to grow and develop. We can ensure the highest level of purity and achieve the perfect composition, down to a molecular level.

Cultivation

Our cells follow their natural process to form muscle and connective tissue, just like they would when growing on an animal. This happens in a vessel we call a 'cultivator'.

Cell-based seafood production will require the appropriate: (1) cell line(s), (2) compatible scaffold, (3) medium, and (4) bioreactor (*Edelman et al., 2005*).

Meat

The entire process from cell to meat takes between 4-6 weeks. Once the meat is ready, it is simply harvested from the cultivator and it's ready to enjoy.

1) Atlantic salmon primary muscle cells have been successfully cultured and differentiated. Fish cell culture growth media used are salt concentration, suitable buffer, temperature, carbon source, pH, growth factors etc. 2) Cultivating three-dimensional tissues relies on the presence of a scaffold, a biocompatible material capable of supporting cell growth and differentiation by providing a suitable morphology, chemical and structural template. Many scaffolds that support various cell cultures use chitosan solutions. 3) *Bioreactors* are complex closed-system environments for producing biomass. It maintains well-controlled environment (temp., pH, DO, nutrients, and wastes), supply of nutrients, gentle mixing (avoid shear damage to cells), gentle aeration (add oxygen slowly to the culture medium, but of large bubbles is carefully avoided which can damage cells on contact), removal of wastes.

Benefits of Cell-Based Seafood Production

- Products are free from pesticides, fungicides and antibiotics.
- No issues like absorption of mercury and toxic industrial byproducts such as PCBs and dioxins in sea water.
- Product is 'clean meat' & 'clean conscience'.
- Technology uses the same cell types with the same genes and nutritional value as wild caught or farmed fish. There is no genetic modification involved.

The U.S. Food and Drug Administration (FDA) and U.S. Department of Agriculture (USDA) created a formal agreement to jointly oversee the production of cell-based meat in March 2019 to tackle the uncertainty surrounding cell-based meat regulation and will allow the USDA and FDA to work in tandem to establish regulations and labeling.

What Critics Say

Critics dismiss it as unnatural 'Frankenmeat', "lab-grown meat", insisting that "they're not fair or accurate".

'Frankenmeat', 'shmeat', or sheet meat are all recent revelation in providing lab-grown burgers that don't require any killing. But one should not expect them to leap from the lab into our frying pan just yet. A lot has to be worked out, like it costs heavily.

However, the technology is still in its infancy, and well-defined research goals have been identified to establish quality improvement, sustainability, scaling of production, lowering price and above all suitable taste for consumer acceptance.

Finless Foods hosts a tasting of edible fish grown from cells in September 2017. Image: Finless Foods

References

Edelman, P. D. *et al* (2005): Commentary: *in vitro*-cultured meat production. *Tissue Eng.* 11, 659–662.

Funk Chris C. & Molly E. Brown (2009): Declining global per capita agricultural production and warming oceans threaten food security. Food Security volume 1; 271–289.

Merino Gorka *et al* (2012): Can marine fisheries and aquaculture meet fish demand from a growing human population in a changing climate? Global Environmental Change. 993, 1-12.

Muir James (2005): Managing to harvest? Perspectives on the potential of aquaculture. Philos Trans R Soc Lond B Biol Sci, 360(1453):191-218.

Myers Ransom A. & Boris Worm (2003): Rapid worldwide depletion of predatory fish communities Nature. vol 423, 280-283.

Sexton, A.E. (2018): Eating for the Post-Anthropocene: Alternative proteins and the biopolitics of edibility. Transactions of the Institute of British Geographers, 43(4), 586-600.

Tanja Schneider *et al* (2019): Digital Food Activism. Routledge publishing, U.K.

Tidwell J.H., G L Allan (2001): Fish as Food: Aquaculture's Contribution. Ecological and Economic Impacts and Contributions of Fish Farming and Capture Fisheries. EMBO rep. Nov.2(11);958-963.

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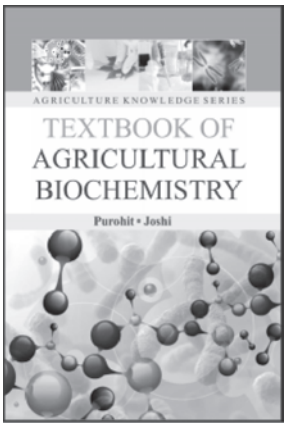

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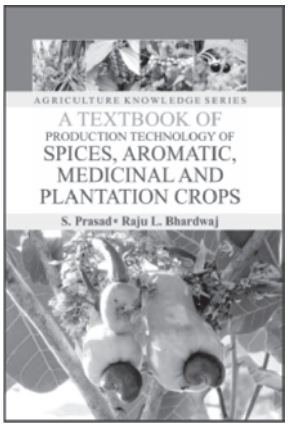

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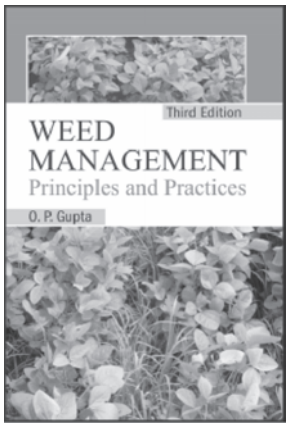

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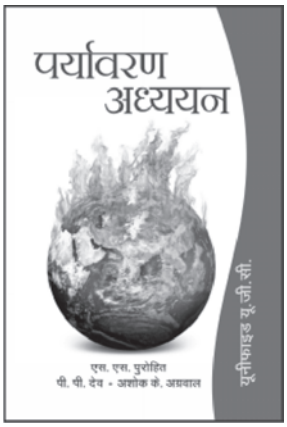

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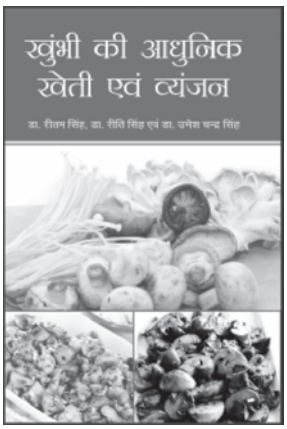

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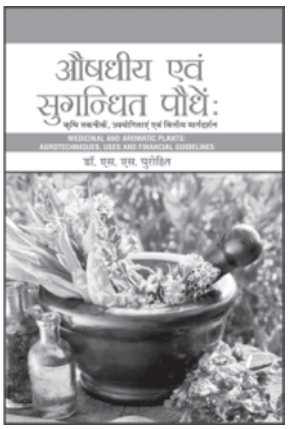

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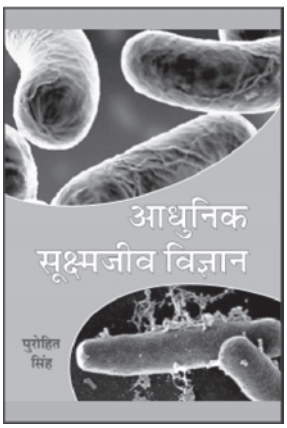

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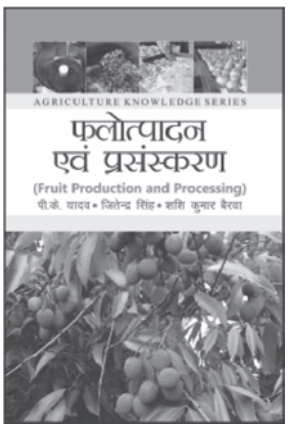

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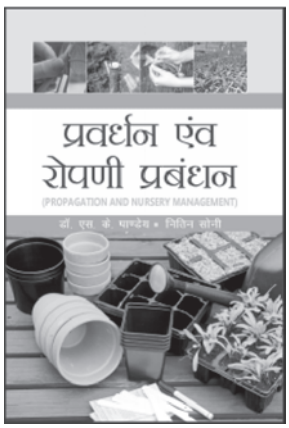

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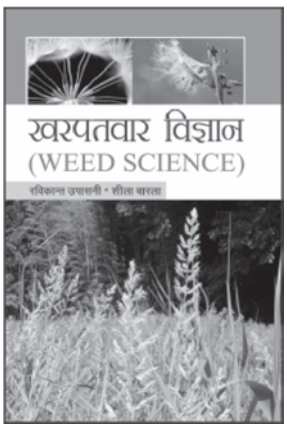

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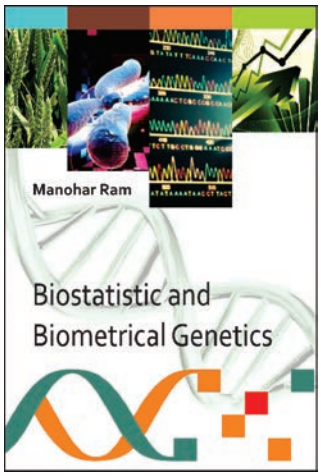

Manohar Ram

ABOUT THE BOOK

The book is prepared to serve as a text book for senior undergraduate and post graduate students. The book is written in simple language and even complex terms have been reduced for easy understanding. Biostatistic and Biometrical Genetics provides up-to-date information about almost all basic principles, basic techniques, biometrical Genetic methods and analysis available in the literature. Due importance has been given to both the theoretical and practical aspects of the subject. The book will serve as an in-depth guide to the students of genetics and plant breeding interested in identifying most biomaterial techniques and knowing their role in crop improvement programmes. The book will also be helpful for the statisticians who are working in collaboration with the geneticists and plant breeders.

CONTENTS

APPENDIX

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